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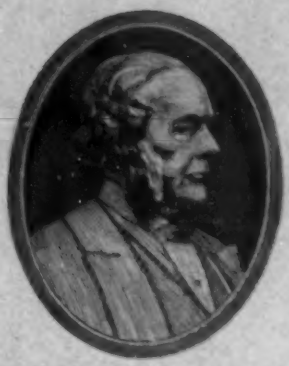

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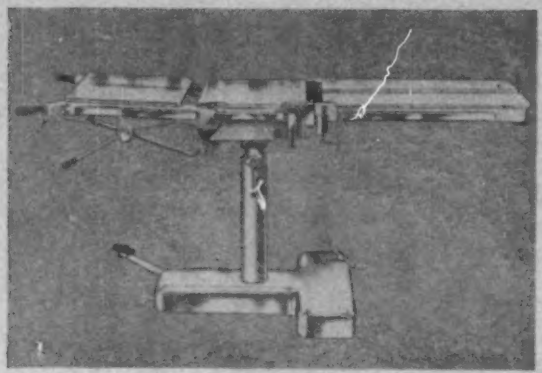

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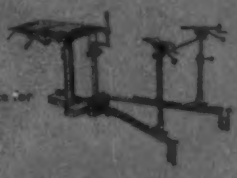

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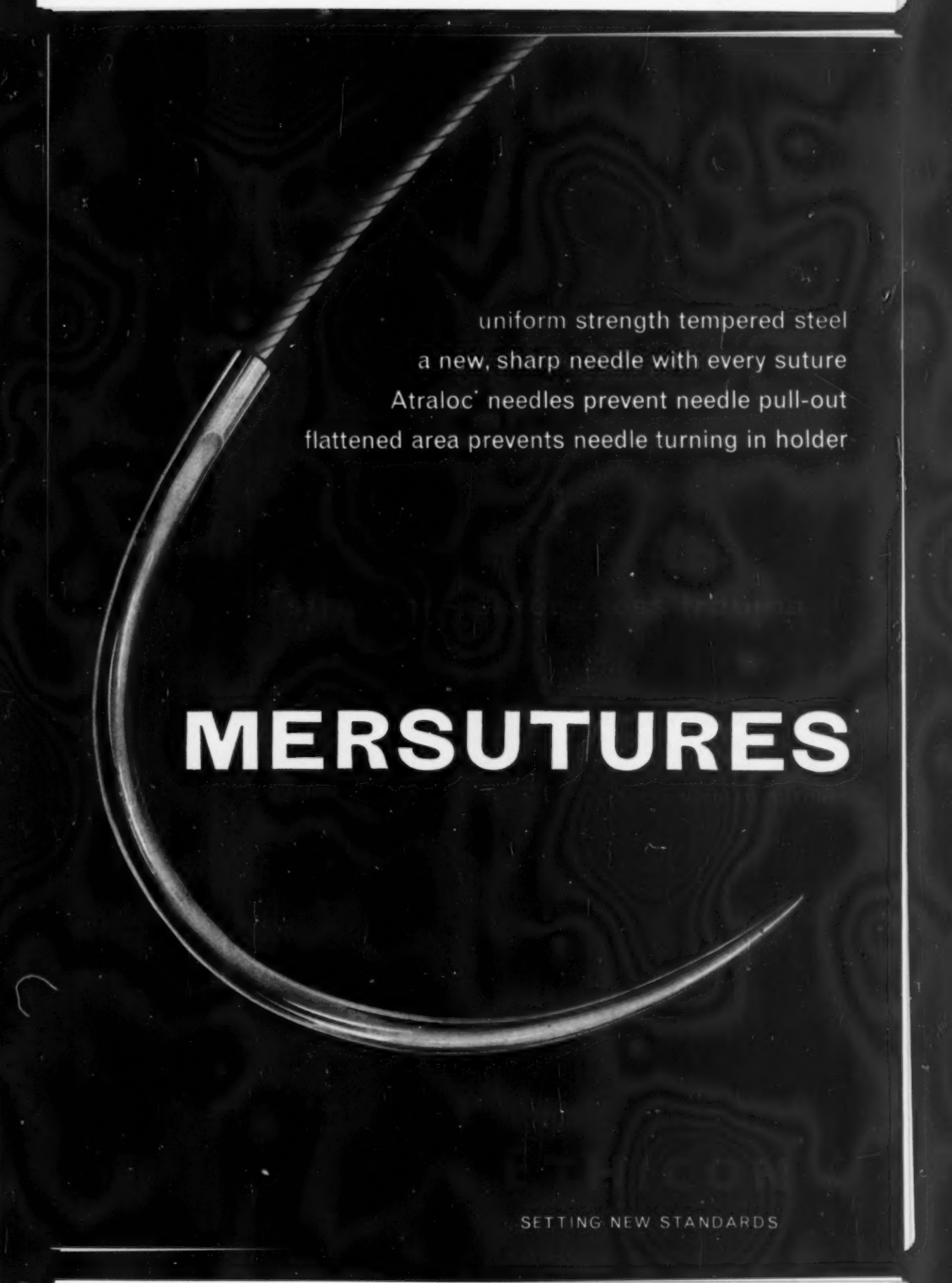
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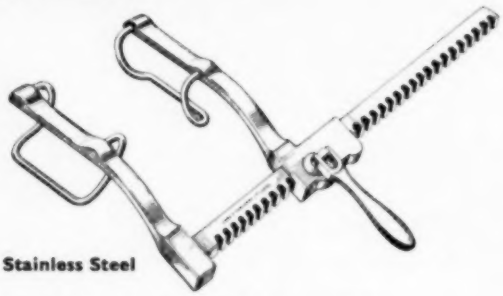

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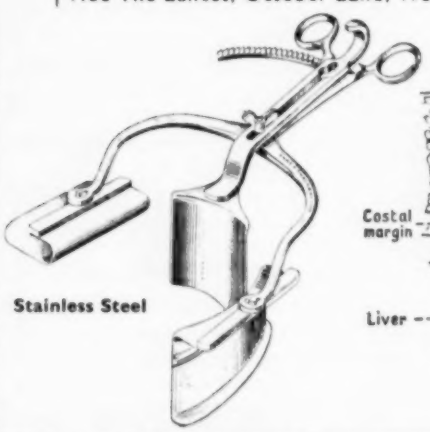

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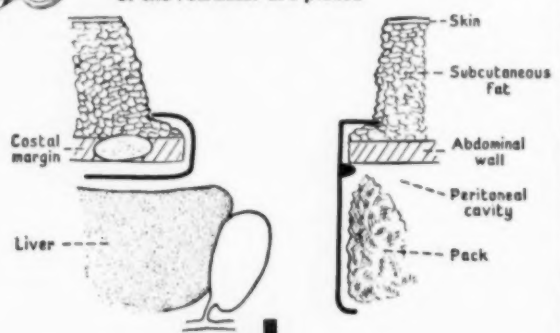

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RIGHT-SIDED OR SEGMENTAL ULCERATIVE COLITIS

BY GEOFFREY WATKINSON, HENRY THOMPSON, AND J. C. GOLIGHER

FROM THE UNIVERSITY DEPARTMENTS OF MEDICINE, SURGERY, AND PATHOLOGY, THE GENERAL INFIRMARY AND ST. JAMES'S HOSPITAL, LEEDS

ONE of the characteristic features of ordinary forms of ulcerative colitis is a consistent tendency to involve the rectum as well as the colon, the condition thus being one of proctocolitis with maximal involvement distally in the rectum and left colon. It is less well recognized that colitis may occur primarily in the more proximal parts of the large intestine whilst sparing the rectum or distal colon; indeed, this occurrence has been denied by many authorities. However, this type of colitis has been well known for the past fifty years. Large series of cases of the condition have been published in America, but it has received little attention in the British literature, despite the fact that two of the earliest clinical descriptions were given by Moynihan (1907) and Mayo Robson (1908).

This communication is concerned with a description of 15 cases with segmental or right-sided colitis which we have observed in the course of the last three years at the General Infirmary and St. James's Hospital, Leeds. The elucidation and management of these patients raised many problems in clinical diagnosis, pathological classification, and treatment, and for this reason we felt justified in reporting our small experience.

DEFINITIONS

The term 'right-sided colitis' introduced by Crohn and his colleagues in 1938 is not a satisfactory one, as the term was later extended by Crohn, Garlock, and Yarnis in 1947 to include cases in which ileum, left colon, or localized segments and transverse colon were involved which had never at any stage affected the right colon. Clearly the application of this term to a varied collection of cases of this kind was misleading.

The alternative term 'regional or segmental' colitis used by Bargen and his associates at the Mayo Clinic since 1930 is also not entirely satisfactory, suggesting a lesion restricted to a very short segment of colon, and, indeed, it has been recently used in this sense by some British authors (Wells, 1952; Kellock, 1957). However, the Mayo Clinic workers later gave the term a much wider meaning, defining it as a "chronic, non-specific, or cryptogenic, inflammatory, ulcerative or hyperplastic lesion involving long, short, or multiple segments of colon *but sparing the rectum at any rate in the first instance*" (Barbosa, Bargen, and Dixon, 1945).

In segmental as well as in distal colitis ileal involvement frequently occurs, the condition becoming one of an ileocolitis. The above definition would allow of the inclusion of other types of ileocolitis, particularly hyperplastic segmental enterocolitis, now designated Crohn's disease. Though the Mayo Clinic group were at pains to exclude such cases, it will be shown that clinical and even pathological differentiation of the various types of ileocolitis may prove extremely difficult.

More recently Brooke and Cooke (1951), Brooke (1954), and Cooke and Brooke (1955) have sought to prove that another distinct variety of enterocolitis exists. Here a primary ileitis or jejuno-ileitis occurs, characterized by numerous 'flea-bite' ulcers in the mucosa only, sparing the deeper layers and not visible from the serosal aspect; the process is thought to be both macroscopically and microscopically dissimilar from both Crohn's disease and backwash ileitis secondary to ulcerative colitis. Steatorrhœa resulting from the jejuno-ileitis irritates the colon, causing typical changes of ulcerative colitis in the large bowel, initially in the right colon, later possibly extending to involve the whole colon. The malabsorptive defect, usually readily demonstrable, commonly induces liver disease, while ileostomy is disastrous, removing the colonic brake to the chronic diarrhœa.

While Brooke and Cooke present a convincing clinical picture in the 16 patients they record, they have only had the opportunity to study the lesion pathologically at operation or autopsy in 2 patients. The failure of other workers to observe similar cases in large series of patients with colitis, together with the fact that the pathological basis has not been clearly identified, has made many workers question the occurrence of this distinct type of ileocolitis.

FREQUENCY

Segmental 'colitis' is a not uncommon condition, and was observed on 15 occasions in a series of 114 patients with various types of colitis encountered in this series, the frequency of 13·1 per cent being similar to that reported by Bockus and his co-workers in Philadelphia, who observed that in 125 patients with ulcerative colitis the disease was of a segmental type in 17 per cent. Other American workers record somewhat reduced frequencies, namely 8 per cent in 600 cases of colitis (Crohn and others, 1947), 6·1 per cent in 299 patients with colitis (Bargen, 1947),

and 3·5 per cent of 708 cases of colitis seen at the Massachusetts General Hospital (Manning, Warren, and Adi, 1955). The precise anatomical location of the disease in our 114 patients with colitis compared with the Philadelphia series shows a very similar distribution in the site of the lesions (*Table I*).

Table I.—Frequency of Segmental Colitis in 114 Cases

	Total	Anatomical Distribution (per cent)			
		Segmental	Entire	Left-sided	Rectum
Leeds 1955–8	114	13	40	29	18
Philadelphia* 1927–53	125	17	49	25	9

* Bockus, Roth, Buchman, Kalser, Staub, Finkelstein, and Valdes-Dapena, 1956.

CASE REPORTS

It is now proposed to describe some of the patients we have observed, to illustrate their varied clinical presentations and the problems which have arisen in their diagnosis and treatment.

1. Most cases of segmental colitis commonly presented with diarrhœa, anæmia, and considerable weight-loss, the lesion usually showing a tendency to extend distally despite medical treatment.

Case 8.—An unmarried girl, aged 21 years, first attended in April, 1955, with a two years' history of anæmia and debility and a seven weeks' history of anæmia, abdominal pains, diarrhœa without blood, and considerable weight-loss. Examination revealed the patient to be febrile (temperature 101° F.) and anæmic, while a tender mass was palpable in the right iliac fossa. Sigmoidoscopy revealed no abnormality. Barium enema showed marked irregularity and loss of haustration of the colon from the cæcum to the mid-transverse colon, indicative of a right-sided colitis; the terminal ileum appeared irregular and dilated (*Fig.* 338 A). Temporary improvement followed hospitalization and steroid therapy, but diarrhœa, pyrexia, and abdominal pain recurred within six weeks of suspending treatment. A repeat barium enema four months later showed that the inflammatory process had spread distally to involve the whole of the transverse and most of the descending colon (*Fig.* 338 B). In view of recurrent symptoms and distal progression of the disease operation was advised, and in August, 1955, a subtotal colectomy with resection of the terminal 9 in. of ileum and the colon down to the junction of the descending and sigmoid colon was undertaken (Mr. H. S. Shucksmith). Following the operation the patient rapidly regained her normal weight, her stools became normal, and she returned to work four months after operation. She is well three years later.

Pathological specimen showed extensive areas of confluent ulceration and many pseudopolypi in the colon, which was maximally involved on the right side. The terminal ileum also showed scattered ulcers and congested areas indicative of a 'backwash ileitis'.

Histologically, the ulcerated areas were floored by vascular granulation tissue heavily infiltrated with plasma cells and lymphocytes frequently arranged in follicles in relation to the ulcerated areas. Both macroscopic and microscopic appearances were typical of ulcerative colitis.

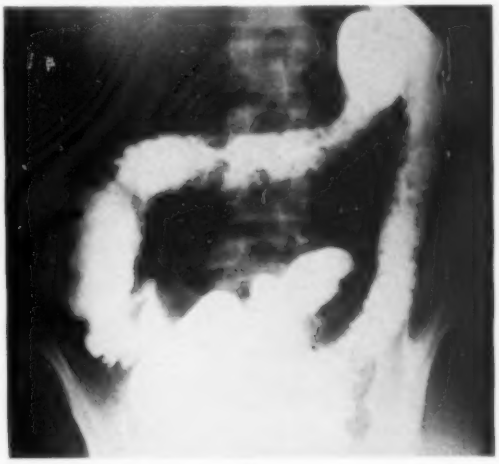
Case 2.—Another young girl, aged 18 years, presented in similar fashion in July, 1954, with diarrhœa without blood, pain, and weight-loss. Sigmoidoscopy was again normal, and barium enema (*Fig.* 339 A) showed changes suggestive of segmental ulcerative colitis, with irregularity of the bowel margins, pseudopolyposis extending from cæcum to splenic flexure, while the terminal ileum also seemed narrowed and diseased. Medical treatment by two courses of steroids and a year's maintenance treatment with cortisone induced a remission of symptoms for the next three years. However, in February, 1958, diarrhœa and abdominal pain recurred, while a tender palpable tumour developed in the right iliac fossa. The possibility of a colitic carcinoma of the cæcum was considered, and the demonstration of a minor defect of fat absorption

A B

Fig. 338.—*Case* 8.—A, Serial barium-enema examinations in a patient with segmental ulcerative colitis, showing in April, 1955, irregularity of bowel margins and loss of haustration of colon to mid-transverse colon, indicative of segmental inflammatory change. B, Despite a temporary improvement on medical treatment, re-examination in August, 1955, shows that the disease has spread distally and proximally to involve the whole of the transverse and most of the descending colon, while the terminal ileum appears dilated and abnormal, indicative of retrograde ileitis.

made the original diagnosis of colitis hard to justify, Crohn's disease seeming much more probable. Radiographs taken in February, 1958 (*Fig.* 339 B), three and a half years after the original film, showed that the colitic process had spread distally to involve the whole of the

A



B

C

FIG. 339.—*Case* 2. A, Barium-enema examinations undertaken in a girl aged 18 years with segmental ulcerative colitis, showing in July, 1954, inflammatory changes involving cæcum to splenic flexure with irregularity of margins and pseudo-polyposis. The terminal ileum appears narrowed and diseased. B, Three and a half years later in February, 1958, radiographs showed the colitic process to have spread distally to involve the descending colon and upper part of pelvic colon, while the terminal ileum seemed more abnormal than previously. C, Pathological specimen of colon removed from *Case* 2, showing typical changes of segmental colitis. Colonic mucosa showed intense congestion, ulceration, and pseudo-polyposis, most marked in the cæcum, ascending, and descending colon, while the terminal ileum showed extensive superficial ulceration with thickening of the intestinal walls. Histologically the appearances were typical of ulcerative colitis.

descending colon and upper part of the pelvic colon, while the terminal ileum seemed more abnormal than formerly.

Operation and the pathological specimen (*Fig.* 339 C) showed typical changes of ulcerative colitis from the cæcum to the upper half of the pelvic colon, the bowel being normal distally, while a typical backwash ileitis involved the terminal ileum. A partial colectomy and ileorectal anastomosis was performed. Examination of the specimen showed intense mucosal congestion, ulceration, and pseudopolyposis most marked in the cæcum and ascending and descending colon, while the terminal ileum showed extensive superficial ulceration with thickening of the intestinal walls. The histological appearances were those of ulcerative colitis.

Case 4.—A young man, aged 20 years, started to have mild diarrhœa, with 2 3 motions daily, in May, 1954, the stools containing traces of blood but no mucus. Diarrhœa and bleeding became steadily worse with up to 8–10 motions per day accompanied by frequent colicky abdominal pains. Finally, pain developed in the anus in November, 1954, which led to his admission to a regional hospital, when he was found to have an anal fissure and fistula. Sigmoidoscopy was then said to show a normal rectal mucosa. He had lost over 1 stone by this stage and was severely anæmic, his hæmoglobin being 50 per cent. With blood transfusion, diet, and oral antibiotics his condition improved. He was discharged home in January, 1955. During the next two years four major exacerbations of diarrhœa occurred requiring hospitalization. Finally, in March, 1957, the patient was admitted to Leeds General Infirmary.

ON EXAMINATION.—He appeared to be well nourished and in excellent general health. No abnormality was discovered in the abdomen. *Rectal examination* showed scars of dorsal anal fissures and related subcutaneous fistula. *On sigmoidoscopy* the lower rectal mucosa was normal with a good vessel pattern; two quiescent pseudo-polypi were observed at 12 cm.; above this the mucosa was slightly granular and bled a little on vigorous contact. *Barium-enema examinations* in January, 1955 (*Fig.* 340 A) showed mild colitis extending from the hepatic flexure to the descending colon, with minimal changes in the upper sigmoid. No polypi were seen. In March, 1956 (*Fig.* 340 B) the proximal half of the sigmoid colon was now definitely implicated and polypi were evident in the descending colon. In January, 1957 (*Fig.* 340 C) the proximal half of the sigmoid was now greatly contracted by the disease and was showing polypi. Very large polypi

were evident in the descending colon. The distal sigmoid and rectum appeared normal and capable of considerable distension.

AT OPERATION (April 11, 1957).—The large intestine from cæcum to lower sigmoid showed typical changes of ulcerative colitis, with two gross strictures and considerable distortion in the transverse colon near the hepatic flexure. The lower ileum appeared normal. Complete colectomy was performed with end-to-end anastomosis between the lower ileum and upper rectum.

FIG. 340.—*Case* 4. Serial barium-enema examination on a young man aged 20 years showing A, In January, 1955, a mild colitis extending from hepatic flexure to descending colon. B, By March, 1956, process had spread distally to involve the sigmoid colon where pseudopolypi were visible. C, Nine months later in January, 1957, the proximal colon was greatly contracted by the disease and polypi are visible in many parts. The distal sigmoid and rectum appeared normal. D, Painting of the operative specimen showing distension and stricture formation in cæcum, ascending, and transverse colon. Numerous digitate polypi were present; many of these were comparable in type, tending to form mucosal bridges where fusion of polypi had occurred. The mucosa of the colon is irregularly congested and extensively ulcerated; the terminal ileum appeared normal. Histologically the appearances were of long-standing ulcerative colitis.

PROGRESS.—Uneventful recovery. Was seen in the out-patient department on Oct. 12, 1958, very fit, having two formed motions per day without blood or slime; sigmoidoscopy showed normal rectal mucosa with good vessel pattern.

PATHOLOGICAL REPORT ON SPECIMEN (*Fig.* 340 D).—*Naked Eye.*—Entire colon 56 cm. long with attached terminal ileum 11·5 cm. long. The cæcum, ascending, and transverse colon were distended, but showed also a number of strictures. Numerous digitate polypi measuring up to 6 cm. in length occurred throughout the colon. Some of these were compound in type. Stricture formation due to bowel mucosal bridges was present where fusion of polypi had occurred. In the transverse colon beyond the hepatic flexure there were five such bridges. Others were present at the hepatic flexure and in the descending colon. The mucosa of the colon was irregularly congested and extensively ulcerated. Terminal ileum appeared normal.

Histology.—The ulcerated areas were covered by leucocytic debris and were floored by vascular granulation tissue infiltrated with lymphocytes and plasma cells. Chronic inflammatory cellular infiltration and fibrosis involved the submucosa and to a lesser extent the serosa. The polypi were hyperplastic mucosal processes and showed no sign of neoplasia. The appearances were of long-standing ulcerative colitis with polyposis.

This form of presentation occurred on several occasions, while progressive distal spread of the disease was often seen; surgery must therefore be not too long delayed lest the rectum become involved and a total colectomy with ileostomy become necessary.

2. Cases presented on three occasions as acute abdominal emergencies simulating those reported by Kellock (1957).

Case 3.—A young housewife, aged 28 years, six weeks after delivery of her second child, developed colicky abdominal pains and diarrhœa which contained traces of blood on two occasions. These symptoms necessitated her urgent admission to hospital on Jan. 3, 1958 as possible case of appendicitis, a diagnosis further suggested by the physical findings, the patient being pyrexial (temperature 102 F.), anæmic, and a tender mass was palpable in the right iliac fossa. Sigmoidoscopy was undertaken with negative results. On Jan. 6, 1958 a laparotomy was performed and a segmental colitis involving the cæcum, ascending and transverse colon was found; a partial colectomy to the mid-sigmoid region was performed with a temporary ileostomy, continuity being restored later by an ileorectal anastomosis. Operation was followed by weight-gain and a return of the stools to normal.

Pathological Specimen (*Fig.* 341).—The colonic mucosa showed large numbers of small interconnected superficial ulcers with long sinuous tracts of ulceration, associated with congestion and intense mucosal œdema. Colitis involved the right and transverse colon maximally, and the colon was normal distally. Histologically, ulcers were floored by vascular pyogenic granulation tissue surrounded by inflammatory hyperæmia, intense submucosal œdema, and fibrosis, all areas being infiltrated by chronic inflammatory cells. These changes were compatible with right-sided segmental colitis with minimal retrograde ileitis.

3. On one occasion segmental colitis presented with intractable anal disease and this symptom was prominent in 6 other patients.

Case 5.—An unmarried woman, aged 54 years, seen in October, 1957, underwent a hæmorrhoidectomy elsewhere in May, 1957. Following the operation she developed diarrhœa, up to 5-6 stools being passed daily which contained slime and rarely blood. In the same period she lost 2 st. in weight, and raw areas in the anal region resulting from her operation refused to heal. Ulcerative colitis was considered as a cause for this delayed healing but was excluded as sigmoidoscopy revealed no abnormality. Crohn's disease was also considered, but seemed unlikely as a barium progress meal (Oct. 30, 1957) revealed no abnormality. Finally, a barium enema was

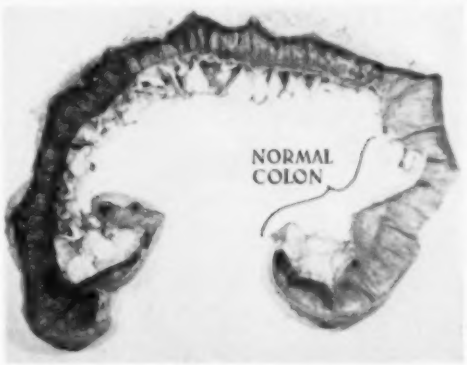


FIG. 341.—*Case* 3. Pathological specimen removed at operation showing segmental ulcerative colitis involving the right and transverse colon. The colonic mucosa shows large numbers of small interconnected superficial ulcers associated with congestive and intense mucosal œdema. Histologically the changes were compatible with ulcerative colitis. A minimal retrograde ileitis was also present.

undertaken (Dec. 17, 1957) and revealed extensive irregularity of the wall of the colon from cæcum to lower sigmoid, with numerous pseudo-polypoidal filling defects indicative of ulcerative colitis sparing the rectum.

The patient responded well to steroid therapy with control of the diarrhœa, gain in weight, and healing of the anal wounds. This remission on medical treatment has continued for nine months; however, it seems not unlikely that the gross structural changes, revealed in the colon radiologically, will eventually relapse and require operative treatment. Should this become necessary the patient would appear to be a suitable candidate for colectomy with ileorectal anastomosis.

Here the radiological appearances leave no doubt that an extensive ulcerative colitis is present with marked pseudopolyposis, but in view of the persistent normality of the rectal mucosa on sigmoidoscopy, the condition is regarded as one of segmental colitis.

4. On three occasions the clinical picture of segmental colitis was so closely simulated by Crohn's chronic regional hyperplastic ileocolitis as to render clinical differentiation extremely difficult.

Case 11.—A housewife, aged 48 years, seen in March, 1957, gave a two years' history of diarrhœa, the stools being loose, pale, and sometimes frothy, but never containing obvious blood or slime. One year previously severe anal pain occurred due to the development of an anal fissure, which was treated successfully surgically. Vague abdominal pains from which the patient had suffered for many years became increasingly severe and colicky, being relieved by defæcation. Her general health deteriorated steadily with a weight-loss of 28 lb. in the last two years. Examination revealed a wasted subject; abdominal examination revealed no abnormality, but rectal examination showed a fistula-in-ano opening internally at the ano-rectal ring, together with a large anterior fissure. Sigmoidoscopy showed the rectum to be normal in its lower part where a vessel pattern could be clearly distinguished, but in the upper rectum slight granularity and

minimal contact bleeding of the mucosa was demonstrated. The stools appeared macroscopically fatty, but although a fat balance was attempted it proved invalid owing to repeated fæcal incontinence. While the clinical picture suggested Crohn's disease barium-meal and follow-through studies showed no abnormality of the small bowel; the barium enema showed an extensive abnormality involving the distal, transverse, and descending colon with narrowing of the lumen, irregularity of the bowel margin, and polypoid appearance of the mucosa, changes which were considered more indicative of colitis than Crohn's disease (*Fig.* 343 A). Operation undertaken on July 18, 1957 revealed a patchy ileitis involving 19 in. of the terminal ileum, apparently of the Crohn's type, with thickening and rigidity of the wall and narrowing of the lumen; the cæcum and right colon appeared normal, but beginning in the mid-transverse colon and extending through the descending and sigmoid colon to the rectum the bowel wall was again thickened, the lumen was contracted, and a characteristic increased vascularity was apparent on the serosal aspect. A total proctocolectomy was carried out with removal of at least 2 ft. of terminal ileum and an ileostomy undertaken. The patient made an uneventful recovery and has gained 3 st. in weight since discharge.

Pathological report on the operative specimen (*Fig.* 342) showed terminal ileum over a distance of 56 cm., ' hose-pipe ' thickening of its wall, and irregular mucosal ulceration; the lesion had skipped the cæcum, ascending and transverse colon, which appeared only distended and sacculated. In the region of the splenic flexure the wall of the colon was thickened and the lumen stenosed. Mucosa here had a cobblestone pattern due to interconnected tracts of ulceration which extended down into the descending colon. Small areas of ulceration were present in the transverse colon and rectum.

Histology.—Areas of ulceration are mainly superficial, floored by vascular granulation tissue infiltrated by acute and chronic inflammatory cells. Submucosa and several layers of the stenosed segments showed œdema, vascularity, chronic inflammatory cellular infiltration, an increased number of lymph-follicles, and fibrosis. A few follicles composed of lymphocytes, macrophages, and occasional giant cells are present in the submucosa muscularis and serosa.

FIG. 342.—*Case* 11. Operative specimen of colon showing typical changes of Crohn's ileocolitis, involving terminal ileum which showed 'hose-pipe' thickening of its wall and irregular mucosal ulceration. A and C, The lesion had skipped the cæcum, ascending and transverse colon, which appeared only distended, but involved the region of the splenic flexure where the colonic wall was thickened and the lumen stenosed. The mucosa in this area showed a typical cobblestone pattern due to inter-connected ulcer tracts which extended into the descending colon. B, Histologically the appearances were those of Crohn's disease.

Macroscopic and microscopic appearances were compatible with Crohn's disease affecting both small and large bowel, but with an extensive skip area between the two lesions.

Radiographs of two patients thought initially to have ulcerative colitis, but later shown to have Crohn's disease, are shown in *Fig.* 343 B, C.

5. Three cases with segmental colitis have simulated clinically the form of enterocolitis described by Cooke and Brooke (1955) with steatorrhœa and liver disease, and the following case is described as it is the only one in which pathological material was available for study.

Case 13.—An unmarried girl aged 20 years was seen in June, 1956. She had been well until the beginning of 1955 when she noticed increasing tiredness, dizziness, loss of weight, and bouts of diarrhœa lasting three or four days, blood being present in the stools on several occasions. Sigmoidoscopy at a regional hospital in January revealed a slightly congested and œdematous rectal mucosa, the bowel contents being blood-stained and highly offensive, suggesting ulcerative colitis. Barium enema at this stage revealed no abnormality. No improvement followed simple medical treatment, and she was finally transferred to St. James's Hospital, Leeds, on May 23, 1956.

Examination revealed a pale, wasted girl with a swollen abdomen, gross ascites, distended anastomotic veins on the abdominal wall, and pitting ankle œdema. Investigations revealed severe anæmia, Hb 41 per cent, marked hypoproteinæmia which, in conjunction with hyperglobulinæmia and abnormal flocculation tests,

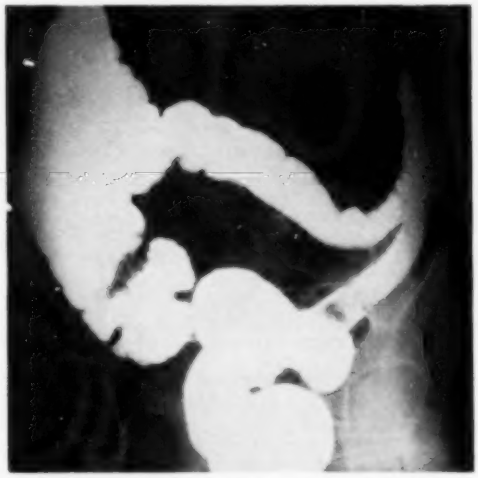
suggested severe impairment of hepatocellular function. Sigmoidoscopy showed minimal changes with a dry granular mucosa with some contact bleeding. Steatorrhœa was macroscopically obvious, while a fat balance showed that absorption was reduced to 62 per cent. Barium meal and follow through showed irregularity of the mucosal pattern in the jejunum and ileum suggestive of inflammatory change; the patient's poor general condition prevented the barium enema being repeated.

Treatment was attempted by fat and gluten restriction, by protein, blood, and electrolyte replacement, while steroid therapy was tried terminally. Diarrhœa, however, persisted and her general condition worsened till she died on July 18, some nineteenth months from the onset of her illness.

Autopsy revealed evidence of segmental colitis from cæcum to hepatic flexure, where many tiny ulcers set in a reddened and œdematous mucosa formed a honeycomb pattern over large areas, while distal to the hepatic flexure the mucosa was œdematous and reddened, but not actually ulcerated. The small bowel also appeared slightly reddened and œdematous, but it was hard to decide whether this was a terminal event. The liver showed evidence of an active portal cirrhosis, and the pancreas showed evidence of chronic pancreatitis with both fibrosis and cystic change.

While the clinical picture here resembled the enterocolitis described by Cooke and Brooke (1955), the absence of pathological changes in the small bowel seemed to distinguish it from this syndrome. The nature of the colonic lesions suggests that this patient also had segmental colitis together with an associated nutritional hepatic cirrhosis and pancreatitis.

Two further cases (*Cases* 14 and 15) with ileocolitis, steatorrhœa, and liver disease have been observed and placed into this clinical category of



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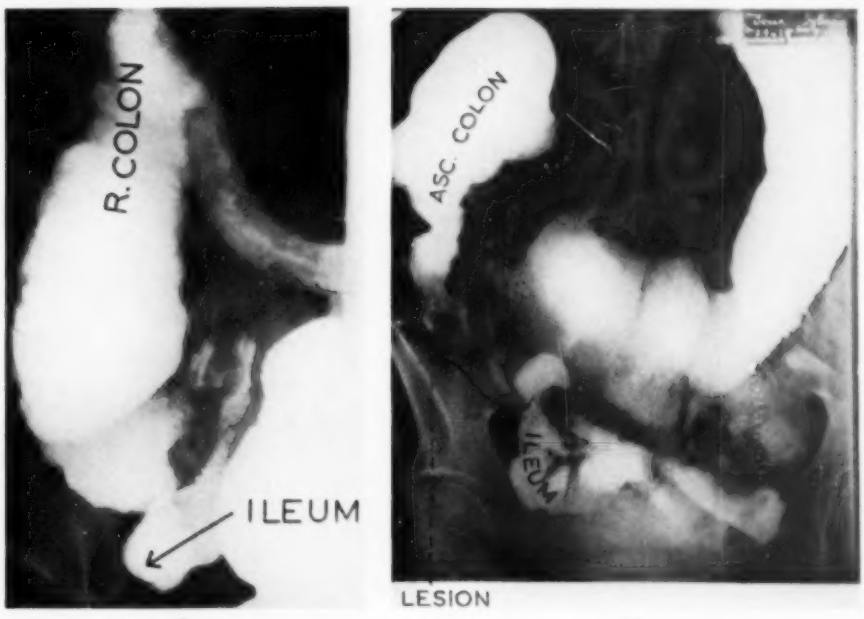


B C

FIG. 343.—Barium-enema examinations from three patients thought initially to have right-sided colitis, but later shown to have Crohn's ileocolitis. **A**, In *Case* 11 the narrowing and irregularity apparent in distal, transverse, and descending colon were misinterpreted as colitis and follow-through studies failed to reveal the ileal lesion. Operation revealed regional ileocolitis involving terminal ileum and splenic flexure (*see Fig.* 342). **B**, Combined ileal and colonic inflammatory changes in patient thought to have ulcerative colitis (*Case* 11). Small-bowel obstruction necessitated operation when ileal lesion was resected and an exacerbation of symptoms led to colectomy and ileorectal anastomosis, both lesions being shown to be due to Crohn's disease. **C**, Involvement of the terminal ileum and ascending colon by inflammatory disease thought to be due to ulcerative colitis (*Case* 12). Steroid therapy given at another hospital led to an exacerbation and miliary spread of pulmonary tuberculosis. Colonic lesion perforated a year later and was shown to be due to Crohn's disease. Patient fit and well three years later.

enterocolitis; both have improved with steroid therapy. The pathological basis for the syndrome in these patients has not been identified.

fact have one of three lesions, namely, true segmental colitis with or without backwash ileitis, Crohn's disease involving the colon primarily or as an extension

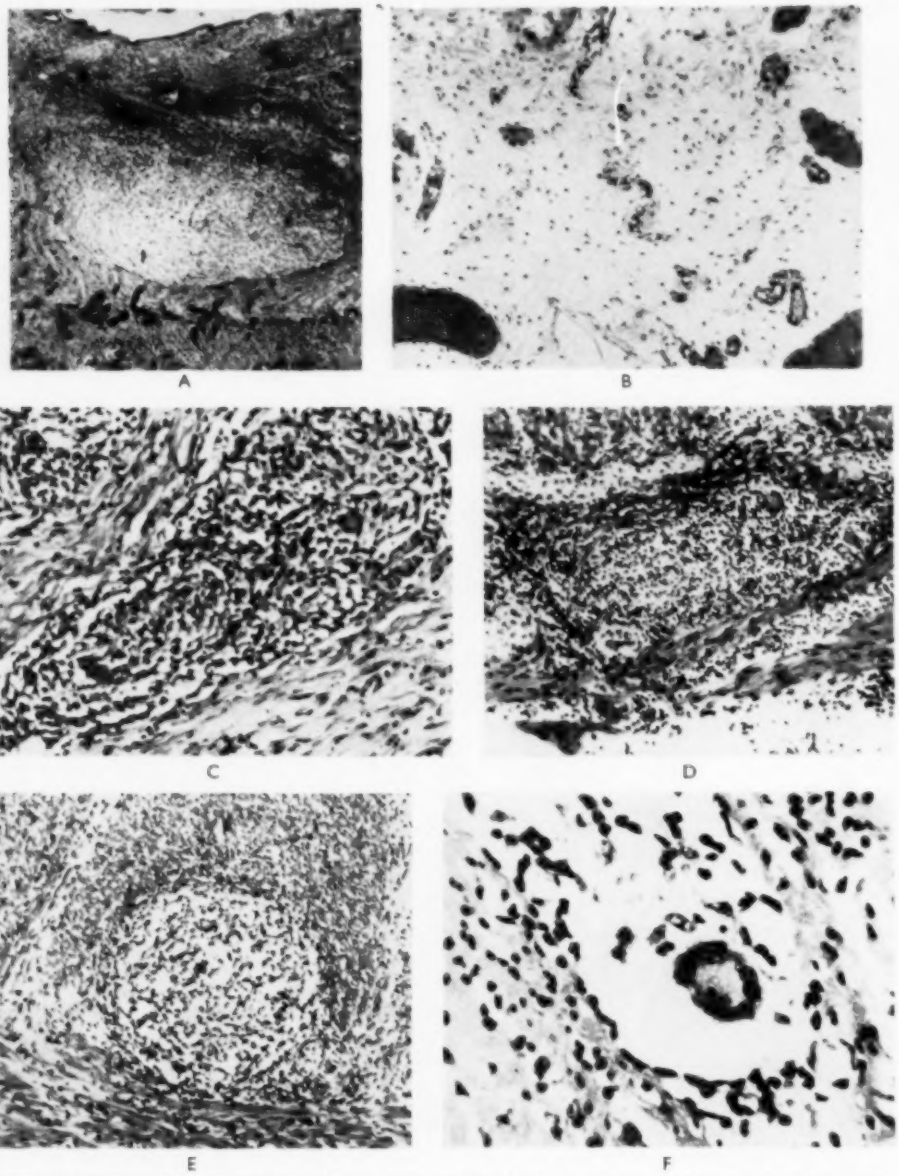


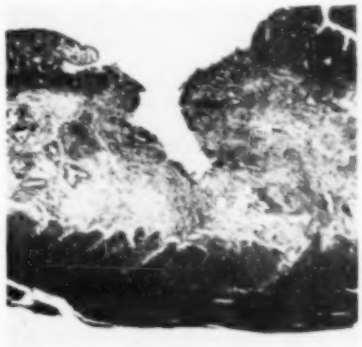
FIG. 344.—Histological features of Crohn's ileocolitis showing A, A low-power view (× 19) with thickening of the bowel wall, chronic inflammatory cellular infiltration, and foci of suppuration. B, Marked submucosal œdema is present (× 75) accompanied by C, Granulomatous inflammation and fibrosis in the serosa (× 130). Frequently this inflammation involves D, The muscle coat (× 82), with the formation of E, Giant-cell follicles (× 93). F, A typical giant cell from one of the follicles (× 375) near a dilated lacteal in the muscle coat.

These case reports serve to emphasize that patients thought clinically to be suffering from segmental ulcerative colitis or colo-ileitis may in from the ileum, and an ill-defined condition which may correspond to the ileocolitis described by Cooke and Brooke (1955).

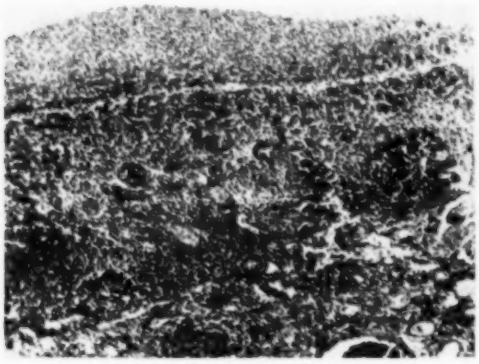
ANATOMICAL DISTRIBUTION AND PATHOLOGY OF LESIONS

In the pathological as well as in the clinical and radiological fields considerable difficulty may be experienced in differentiating the various types of segmental colitis and ileocolitis. Some authors, such as Lumb (1951, 1958), take the view that the lesions known as regional enteritis and regional enterocolitis (Crohn's disease), regional ulcerative colitis, and chronic idiopathic ulcerative colitis, do not exist as separate entities so much as variants of an essentially similar process, manifesting itself in different areas of the bowel. We regard this as much too nihilistic an attitude, for it seems to us, as to Crohn and others (1947), Warren and Sommers (1954), Neuman and others (1954), and Lockhart-Mummery and Morson (1959), that a clear distinction can usually be drawn pathologically between Crohn's type of enteritis and ordinary diffuse ulcerative colitis. The gross appearances are perhaps most helpful in making this differentiation. Crohn's enteritis is associated with considerable thickening and induration of the bowel wall leading to a hose-like appearance. Encroachment of the lumen with stenosis is readily seen on cross-section. The mucosa may have a cobblestone pattern due to the presence of narrow interconnected tracts of ulceration or it may show crevices, fissures, or sinuses leading into the serosal tissues. Skip lesions may be present (*see Fig.* 342).

In ulcerative colitis the wall of the colon is only slightly or moderately thickened. Diffuse surface ulceration is usually present and there is a marked tendency for pseudo-polyposis to occur. It must be remembered that there may be an associated back-wash ileitis (*Figs.* 339, 341).



A



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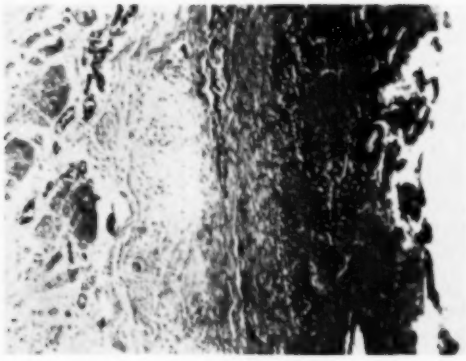

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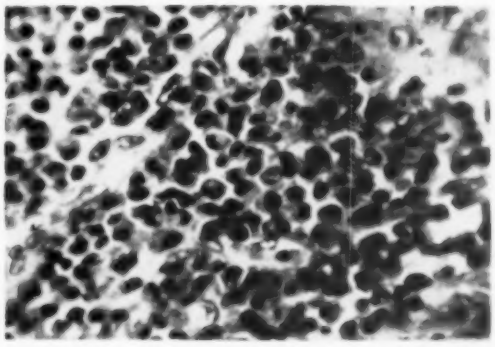

E

FIG. 345.—Histological features of ulcerative colitis showing A, Typical ulcer (× 19) involving mucosa and submucosa; absence of submucosal œdema is strikingly less than in Crohn's disease. B, The base of the ulcer (× 60) consists of vascular granulation tissue caused by fibrinopurulent exudate also visible C, in the edge of an ulcer (× 75). D, Variable degrees of chronic inflammatory cellular infiltration of the mucosa and submucosal fibrosis are present (× 52). E, This exudate consists largely of plasma cells (× 488).

Histologically, the thickening in Crohn's disease is due to œdema, granulomatous inflammation, and fibrosis of all layers of the bowel wall (*Fig.* 344 A). The muscle coat is least affected. Œdema (*Fig.* 344 B) is a prominent feature in the early stages. Foci of suppuration are associated with the fissures and sinuses leading into the submucosa and serosa. Chronic inflammatory cellular infiltration is severe (*Fig.* 344 C, D). Non-caseating giant-cell follicles (*Fig.* 344 E, F) occur in a high proportion of cases in the diseased gut and regional lymph-nodes. The inflammatory process may extend to involve the adjacent mesenteric tissue.

In ulcerative colitis the mucosa shows extensive ulceration. The ulcers frequently extend into the submucosa (*Fig.* 345 A), but only occasionally do they involve the muscle coat. The ulcer base consists of vascular granulation tissue (*Fig.* 345 B, C) covered by fibrinopurulent exudate and infiltrated by leucocytes. The adjacent tissues show severe chronic inflammatory cellular infiltration (*Fig.* 345 E) and an increased number of lymph-follicles. Giant cells and occasional giant-cell follicles can be seen in otherwise typical cases of ulcerative colitis. Regeneration and hyperplasia in the mucosa lead to pseudo-polyposis. Increased vascularity is prominent in the mucosa, submucosa, and serosa in many cases; dilatation of the vessels may be almost telangiectatic at times. The submucosa usually shows some fibrosis (*Fig.* 345 D).

These subtle differences between the two conditions have led us to believe that Crohn's disease is a granulomatous process involving all layers of the bowel wall, whereas ulcerative colitis appears to be a disease with diffuse ulceration of the mucosa and secondary inflammatory changes in the other layers.

The belief that Crohn's disease and ordinary ulcerative colitis are separate conditions is further supported by the difference in the prognosis after surgical treatment. Recurrence of the latter disease after its excision by proctocolectomy and ileostomy is unknown, while the most distressing feature of Crohn's enteritis is the great frequency with which the lesion re-asserts itself in the remaining bowel after its excision or short-circuiting—in up to 80 per cent of the cases on a 10-year follow-up, according to Van Patter, Bargen, Dockerty, Felderman, Mayo, and Waugh (1954).

We consider, then, that there are ample grounds for recognizing Crohn's ileitis and ileocolitis on the one hand, and ordinary universal or primarily left-sided ulcerative colitis, on the other, as distinct entities. With segmental lesions of the type with which we are concerned in this paper the problem is to decide whether they correspond to a Crohn's enteritis or to an ulcerative colitis, or represent something different.

In 3 of our 15 patients only clinical and radiological information was available, but in the remaining 12 a precise anatomical and pathological identification of the disease process was possible on the basis of operative or autopsy material. The anatomical extent of the lesion and the final considered diagnosis in each of our cases are indicated in *Fig.* 346.

In 9 cases a segmental ulcerative colitis was present which affected the right colon in all save one instance. A variable amount of transverse and left colon was involved in 7 cases and the terminal ileum by a retrograde or 'backwash ileitis' in 5. In no case was the rectum affected, at any rate in its lower two-thirds. The pathological appearances of the colonic lesions were unmistakably those of ulcerative colitis with ulceration and gross pseudo-polyposis

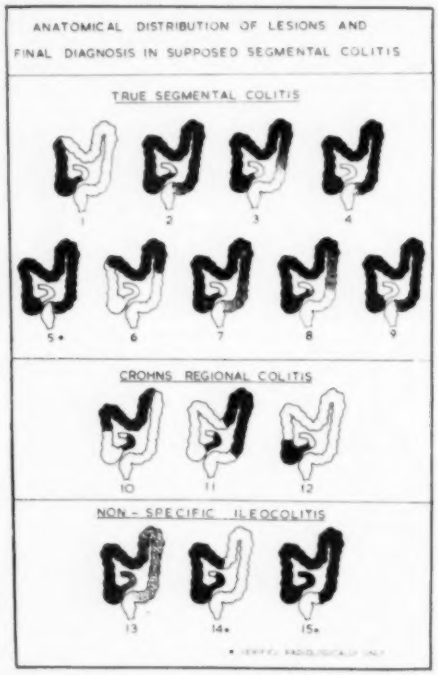

FIG. 346.—Illustrates the anatomical distribution of lesions and final pathological diagnosis in 15 patients with segmental colonic inflammatory lesions. This diagnosis was based on the examination of pathological material in 12 patients, but in 3 cases, *Cases* 5, 14, and 15, was based on clinical and radiological findings.

in 5 instances, while the histological findings were in keeping with this diagnosis. The pathological findings in this group of cases could all be plausibly explained as being due to an ulcerative colitis originating in the right colon and extending a variable distance proximally and distally from this point in the manner suggested by Crohn and Berg (1938). In one patient, *Case* 6, segmental involvement of the transverse colon by an inflammatory process in the manner described by Kellock (1957) had induced diarrhœa and rectal bleeding simulating colonic neoplasm. However, the lesion proved at operation to be segmental colitis and was confirmed histologically from a biopsy of the lesion.

In 3 patients, *Cases* 10, 11, and 12, no true ulcerative colitis was present, the colonic lesions being shown to be of the Crohn's type involving the whole colon, left colon, and cæcum, respectively. In all instances coexisting ileal lesions were present separated by a 'skip' area of 4 in. of normal ileum from the colonic lesion (*Case* 10), by 10 in. of normal colon from a 'skip' lesion in the region of the splenic flexure and descending flexure (*Case* 11), and in

Case 12 involved the cæcum in continuity. No definite information was available to show whether these two conditions arose concomitantly or consecutively.

To 3 patients the unsatisfactory classification of ileocolitis of indeterminate origin was assigned. In two of these (*Cases* 14 and 15) no operative or pathological material was available, the extent of disease being judged radiologically. In *Case* 12 a right-sided colitis extending from cæcum to hepatic flexure was demonstrated at autopsy in conjunction with hepatic cirrhosis and chronic pancreatitis, but the small intestine did not show the appearances of fine ulceration described by Brooke and Cooke (1951); the only abnormality observed in it was a slight œdema of the lower ileum.

CLINICAL FEATURES

The broad symptomatology of the group of patients as a whole will now be reviewed and it will be shown that the clinical picture differs only in degree from ordinary ulcerative colitis. Further, few clinical features exist from which the three types of ileocolitis can be identified. Symptoms encountered in our small series will be contrasted with the vast experience of segmental colitis reported by Crohn, Garlock, and Yarnis (1947) and Neuman, Bargen, and Judd (1954).

Age and Sex Incidence.—It seemed in our small series that women were affected more often than men with a ratio of 4 : 1, differing from our experience of left-sided colitis where the ratio was 1·6 : 1. However, the 201 patients reported by Neuman and others (1954) at the Mayo Clinic showed no such female predominance, men and women being affected with almost similar frequency (1·1 : 1). An almost similar frequency was reported by Crohn and others (1947), 1·4 : 1.

While left-sided ulcerative colitis in women occurred most commonly in the fourth and fifth decades, a younger age-group appeared affected by segmental colitis. Findings were similar to the Mayo Clinic workers, who reported maximal frequency in the second, third, and fourth decades, with a mean age onset in both series approximating 30 years.

Symptoms.—The symptoms observed in the 15 patients presenting with segmental colitis will now be detailed. Diarrhœa was eventually observed in all 15 cases, being the presenting symptom in 12 patients, a similar frequency to the Mayo Clinic series where 86 per cent developed this symptom. The stools contained blood in only 6 of our patients and in 49 per cent of the American series, bloody diarrhœa being therefore far more common in predominantly left-sided colitis than in segmental colitis. However, as approximately half the patients affected respectively by colitis, Crohn's disease, or enterocolitis had blood-stained stools, this symptom did not assist the clinical differentiation of the three pathologies. Colicky abdominal pain, frequently relieved by defæcation and severe enough on occasion to simulate acute abdominal emergencies, was a pronounced symptom in 11 patients, being a presenting symptom on two occasions, a finding very much in accord with the Mayo Clinic workers who observed it in 69 per cent of their patients.

Marked deterioration of general health accompanied by losses of weight of the order of 1–4 st. occurred in 13 patients, this symptom being prominent in the American series where 73 per cent showed similar weight reductions. Both weight-loss and abdominal pain occurred with similar frequency in all 3 types of ileocolitis. Perianal disease occurred frequently and was a presenting symptom in one instance.

Clinical Findings.—Considerable constitutional disturbance frequently accompanied the illness; moderate pyrexia was present in the majority of cases (12 of 15), while pallor and anæmia were frequently encountered (10 of 15). These features were rather less obvious in the Mayo Clinic series, where 40 per cent of patients were pyrexial and 30 per cent anæmic at some stage of their illness.

An abdominal mass, usually in the right iliac fossa, was palpated in 5 of our 15 patients with segmental colitis, a frequency far in excess of the Mayo Clinic series where palpable tumours developed in only 3 per cent. Clinical experience would suggest that the formation of masses would be more common in Crohn's disease or in non-specific enterocolitis; however, abdominal swellings were entirely confined to 5 patients with true segmental colitis. Stools appeared macroscopically fatty in 8 of the 15 patients thought to have segmental colitis, and excessive fat excretion was confirmed biochemically in 6 instances, shown later to have either Crohn's disease or enterocolitis. However, in 2 patients with true segmental colitis a minor impairment of fat absorption was confirmed biochemically, showing that although manifest steatorrhœa would suggest the presence of Crohn's disease or enterocolitis, rare cases of colitis will demonstrate some degree of malabsorption. Cooke and Brooke (1955) also stress the rarity of steatorrhœa in ulcerative colitis, finding it in only 1 of 26 patients studied by fat balances. Its presence, they feel, suggests a small intestinal defect if systemic complications such as pancreatitis, liver disease, or amyloidosis have been excluded. Steatorrhœa, therefore, seems most clearly to distinguish an ileocolitis from true segmental or distal colitis.

A tendency for segmental colitis to spread either distally or proximally was stressed by both groups of American workers (Crohn and others, 1947; Neuman and others, 1954). Extension was shown to have occurred distally radiologically in 3 of our 9 patients with true segmental colitis (*see Figs.* 338–340), while the frequency of ileal involvement is ample evidence for the tendency to proximal extension. It is necessary therefore to perform periodic radiological examinations on patients under medical treatment even though the process appears quiescent clinically, lest the disease extend distally to involve the rectum, rendering impractical the more satisfactory operation of ileorectal anastomosis.

Local Complications.—Complications developing in the colon in segmental colitis, such as perianal disease, pseudo-polyposis, stricture formation, perforation, and liability to carcinomatous transformation, do not appear to differ in nature or frequency from the more distal types of ulcerative colitis.

Perianal Disease.—Though the diseased colon in segmental colitis is separated from the anal region by a variable length of normal bowel, comprising rectum and often some of the distal colon, the same predisposition to the occurrence of anal abscesses

and fistulæ apparently exists as in the more common distal types of colitis. This tendency was stressed by Crohn and others (1947), who reported that 22 of their 77 patients with segmental colitis had anal complications, while Neuman and others (1954) reported that 22 per cent of the 201 patients studied at the Mayo Clinic developed this complication. Perianal disease was even more common in our experience, developing in 6 of our 15 patients and being a presenting symptom in one instance; indeed anal complications occurred slightly more commonly in our experience in segmental than in distal colitis, where 31 of 108 patients, or 28 per cent, developed anal abscesses or fistulæ. Both colitis and Crohn's disease were complicated in our small series by perianal disease; however, probably fortuitously, anal disease did not develop in our 3 patients with non-specific enterocolitis.

Pseudo-polyposis.—In segmental colitis the tendency to inflammatory polypoid hyperplasia of the colonic mucosa occurred with a similar frequency to distal types of colitis; thus, 5 of our 15 patients thought to have segmental colitis showed this complication, the lesion being only present in patients eventually shown to have true ulcerative colitis. Similarly, pseudo-polyposis was observed in approximately one-third of the 201 patients studied by the Mayo Clinic workers (Neuman and others, 1954).

Stricture Formation with or without Obstruction.—Crohn and Berg (1938) claimed initially that there was little tendency to stricture formation in segmental colitis, but later, Crohn, Garlock, and Yarnis (1947), with wider experience of the condition, admitted that stenosis did occur, 2 of their 77 cases being admitted with intestinal obstruction. Localized stricture was also observed by Neuman and others (1955) in 14 of their 201 patients with segmental colitis, although only 1 developed obstruction, while Kellock (1957) reports 8 cases with localized segmental colitis which presented with intestinal obstruction. Manning and others (1955) observed obstruction in 5 of 34 patients with segmental colitis, while Branch and Sledge (1955) reported 12 further examples with obstructive symptoms.

One of our patients, *Case* 10, developed a small-bowel obstruction necessitating laparotomy, but was later shown to have Crohn's ileocolitis. A colonic stricture developed in the right colon in one patient, *Case* 1, which was not far short of complete obstruction, and another patient, *Case* 4, had two well-marked strictures of the transverse colon (*see Fig.* 340 D). A colonic stricture in a third patient, *Case* 11, resulted from a 'skip' area of Crohn's disease involving the colon in the region of the splenic flexure (*see Fig.* 341). It would seem that as regards stenosis, segmental colitis does not behave very differently from ordinary forms of colitis, but, if anything, may be more prone to form extremely localized narrowings.

Perforation.—As in distal ulcerative colitis, some cases with segmental colitis develop perforations, and this complication occurred in 13 of the 201 Mayo Clinic patients, or in 6·4 per cent. Perforation occurred in 1 patient in this series, *Case* 12, but this patient was later shown to have Crohn's disease of terminal ileum and cæcum.

The Development of Carcinoma.—Neither Crohn and others (1947) nor Neuman and others (1954) found that any of their patients with segmental colitis developed carcinoma in the affected bowel, but Manning and others (1955) observed this change in 2 of their 34 cases. A carcinomatous stricture also developed in 1 of the 16 patients with non-specific enterocolitis reported by Cooke and Brooke (1955). It would be surprising if this risk did not apply to segmental colitis in exactly the same way as it has been shown to do in ordinary colitis (Bargen, 1928; Lynn, 1945; Counsell and Dukes, 1952). Although none of our patients developed a carcinoma, the possibility of malignant transformation was considered as a cause of an abdominal mass in one patient (*Case* 2).

Systemic Complications.—Systemic complications frequently accompany segmental colitis, arthritis, skin lesions, and liver disease seeming to merit discussion.

Arthritis.—Arthritis is a well-known complication of the more distal forms of ulcerative colitis, estimates of frequency varying between 4 per cent (Bargen, 1930) and 22 per cent (Kirsner and others, 1957). Only recently has the specific variety of arthritis associated with colitis been identified by Bywaters and Ansell (1958) and Wright and Watkinson (1958), who estimated its frequency at 22 per cent and 16 per cent respectively in surveys of more than 100 subjects with ulcerative colitis in each instance.

It is not surprising therefore that arthritis is a not infrequent accompaniment of segmental colitis, occurring in 15 per cent of the 201 patients reported by the Mayo Clinic workers (Neuman and others, 1954), in 13 per cent of 77 patients with segmental colitis reported by Crohn and others (1947), and in 6 of 22 patients with either segmental or ileocolitis reported by Bockus, Roth, Buchman, Kalser, Staub, Finkelstein, and Valdes-Dapena (1956), percentages which did not differ materially from those encountered in true ulcerative colitis. Typical colitic arthritis was observed in 3 patients with segmental colitis in our series, 1 of whom was later shown to have Crohn's ileocolitis.

Cutaneous Lesions.—The tendency in segmental colitis to develop cutaneous lesions, particularly erythema nodosum and pyoderma gangrænosum, was stressed by Neuman, Bargen, and Judd (1954), who observed these eruptions in 17 of their 201 patients (8·4 per cent), somewhat similar frequencies being reported by other American workers, namely 3 in 77 by Crohn and others (1947), and 2 in 22 by Bockus and others (1956).

Nodose eruptions developed in 2 patients, *Cases* 2 and 10, the latter case being an example of Crohn's ileocolitis.

Liver Disease.—Liver disease in ulcerative colitis is well recognized, but its frequency, aetiology, and pathological basis have not been clearly established. Anæmia and malnutrition are common features of ulcerative colitis, the liver being continually assaulted by bacteria and toxins from the ulcerated colon, while numerous transfusions bring with them the hazards of serum hepatitis. While fatty changes or fibrosis of the liver in fatal cases of ulcerative colitis are often observed, the frequency being estimated at between 4 and 40 per cent (Hoffbauer, McCartney, Dennis, and Karlson, 1953; Kleckner, Stauffer,

Bargen, and Dockerty, 1952), clinical manifestations of liver disease in distal ulcerative colitis are uncommon. We would confirm the opinion of Cooke and Brooke (1955) that "liver function tests have only occasionally been abnormal" and "fatty changes have not infrequently been encountered". Cooke and Brooke (1955) stressed the frequency of liver damage at a relatively early stage of the disorder in non-specific enterocolitis, the change being demonstrated pathologically in 2 patients at autopsy and in 2 at laparotomy; biochemical evidences of liver damage were present in the majority of their 16 patients.

Clinical evidence of hepatic cirrhosis was obvious in one of our patients, *Case* 13, and was suggested by hypoproteinæmia with hyperglobulinæmia in a second, *Case* 15. The lesion was confirmed histologically at autopsy in one instance and by liver biopsy in the other. Abnormal liver-function tests occurred in a third patient, *Case* 14, though the process was not confirmed histologically. Evidences of liver disease in these 3 patients with ileocolitis and steatorrhœa led to their classification as non-specific enterocolitis.

DIAGNOSIS

It is essential to remember that ulcerative colitis can occur in the absence of any sigmoidoscopic abnormality. Diagnosis, then, rests on clinical and radiological examination. These radiological appearances differ only in degree from the more distal types of ulcerative colitis, with distortion of the mucosal pattern, loss of haustration, and 'moth-eaten' margins to the colonic outline.

However, a precise radiological diagnosis may be difficult to achieve, particularly the recognition and interpretation of any associated ileal lesion, as is well exemplified in the faulty pre-operative radiological diagnosis in several of our patients.

It has also been shown that no clinical criteria exist that will clearly distinguish segmental from the more distal types of ulcerative colitis, or enable it to be differentiated from Crohn's disease or from other ill-defined forms of enterocolitis.

Occasionally, as has been pointed out by Crohn and others (1947), confusion may arise in the diagnosis in some cases of segmental colitis where the bowel symptoms are so slight as to be completely overshadowed by constitutional and metastatic manifestations such as fever, weight-loss, anæmia, arthritis, skin lesion, or iritis. This was not, however, our experience, the symptomatology being such as to focus attention primarily on colon or small intestine.

TREATMENT

Medical.—As in the more distal types of colitis, medical treatment will naturally be tried initially. The outcome of medical treatment in 10 patients is summarized in *Table II*; 9 received steroids and 1 sulphonamides alone. In 3 patients this treatment failed within a few weeks, but with 7 patients remissions in the condition were induced for periods varying between one to three years, and in 3 patients remissions have been maintained to date and medical treatment is being continued. One patient, *Case* 6, received sulphonamides only, following an emergency operation of exploratory laparotomy. A prolonged remission of more than four years followed this treatment and the patient is still well.

Table II.—Outcome of Medical Treatment in Segmental Colitis

	Total	Given Medical Treatment	Failed Initially	Remission Induced 1–3 yr.	Remission Maintained to Date	Late Failure
Leeds	15	10*	3	7 1–7 yr.	3	4 1–8 yr.
Mayo Clinic	201	95		33 (33·3 per cent)		62 (66·7 per cent)

* Steroids 9, Sulphonamides 1.

The response, therefore, of segmental colitis does not differ from that obtained in ulcerative colitis where approximately half the patients will undergo symptomatic remission on steroid therapy. The Mayo Clinic workers (Neuman, Bargen, and Judd, 1954) gave medical treatment, not including steroids, to 95 of their 201 patients and induced remissions varying between one to seven years in 33 per cent. However, failure occurred within periods of six months to five years in the remainder.

Surgical.—The outcome of surgical treatment is summarized in *Table III* and was more successful. In 8 patients it was found possible to perform the very attractive procedure of partial colectomy with ileorectal anastomosis, thus preserving natural continence, but in 2 patients, *Cases* 7 and 11, rectal involvement made it necessary to perform total colectomy and ileostomy. Additional operations were necessary in 4 patients, 2 requiring laparotomy to determine the nature of the colonic lesion, one for a perforated Crohn lesion in the cæcum (*Case* 12), and one for small intestinal obstruction (*Case* 10). We have been impressed with the success of ileorectal anastomosis in this group of patients who have remained well for periods varying between two

Table III.—Surgical Treatment in 15 Cases of Segmental Colitis

Total	Surgery Undertaken			Emergency Operations	Elective Partial Colectomy	
	Total	Early	Late		Ileorectal Anastomosis	Ileostomy
15	10	5	5	4*	8	2

* 2 laparotomy, 1 perforation, 1 obstruction.

months to three years after this operation. It must be admitted, however, that none of them has really been followed for very long periods. We can, however, quote the findings of American workers in this regard.

Garlock (in Crohn, Garlock, and Yarnis, 1947) conducted a survey of the late results in 46 patients with segmental colitis who survived various anastomotic operations, with or without resection of the involved gut, at the Mount Sinai Hospital, New York. All the cases had been followed up for at least six months, with an average follow-up period of roughly three years. Only 3 of them subsequently experienced disease in the rectum and had to proceed to ileostomy. Other reports are rather less enthusiastic. At the Mayo Clinic, according to Neuman and others (1954), 38 patients survived short-circuiting operations or resections with anastomosis for segmental colitis. Of these, 3 died within six months, and 13 are known to have developed recurrence subsequently. Manning and others (1955) found that in 19 of 34 cases with segmental lesions treated along these lines at the Massachusetts General Hospital, the operation was successful in rendering the patient symptom-free for an average period of 4·6 years. In 15 cases the operation failed to halt the disease; 7 of these were restored to health by ileostomy. Of the remaining 8 cases, 5 patients are dead and 3 are living with symptoms.

These latter two reports certainly provide a valuable corrective to undue optimism regarding the ultimate results of ileorectal and ileocolonic anastomosis, but they show quite conclusively that the rectum often remains enduringly free from disease after these operations. These results seem to us to justify fully the choice of resection with anastomosis as the initial surgical procedure in segmental colitis. Indeed, from what we know of the evolution of this form of colitis and its tendency to progress distally, we would go farther and agree with Garlock (in Crohn and others, 1947) that the best prophylactic measure to protect the rectum from involvement will often be a timely resection. The clinician who persists with unsuccessful medical treatment for too long assumes a very heavy responsibility, for, apart from incurring a risk to life, he may also discover, to his intense chagrin, that he has allowed the rectum to become diseased and has thus missed the opportunity of doing an anastomotic operation with a very fair chance of lasting cure and retention of normal rectal function.

DISCUSSION

A form of segmental inflammatory disease therefore exists involving the more proximal part of the colon initially and sparing rectum and colon, tending to spread longitudinally both proximally and distally, eventually to involve both rectum and terminal ileum and become an ileocolitis. The description of such a lesion is difficult; both 'right-sided' and 'regional' colitis are confusing terms and 'segmental' colitis seems the designation least open to criticism. However defined, the clinical syndrome may result from three pathological processes, namely, true ulcerative colitis, Crohn's ileocolitis, and other types of non-specific enterocolitis. These conditions seem not only difficult to separate pathologically, but almost impossible to distinguish on clinical grounds.

Reference has already been made to the difficulty experienced by many pathologists in identifying the causal disease process, Lumb (1951) notably finding distinction wellnigh impossible. However, others (Crohn and others, 1947; Warren and Sommers, 1954; Neuman and Dockerty, 1954; Morson and Lockhart-Mummery, 1959) felt differentiation was possible on pathological grounds. Some clinicians also (Paulley, 1958), struck by common personality factors and by the influence of emotional stress in precipitating onset and relapse in both colitis and Crohn's disease, feel that such similarities exist between the two diseases that little useful purpose is served by distinguishing them. Too few pathological studies have as yet been made to decide whether non-specific enterocolitis exists as a separate entity.

We feel, however, that the three diseases described differ so strikingly in natural history, in tendency to recurrence after surgery, and in response to medical treatment that it is incumbent on both clinician and pathologist to attempt to differentiate them so that appropriate treatment can be given and a suitable prognosis made. The difficulties inherent in the task have been illustrated by a description of 15 patients with segmental colonic inflammatory lesions due to all three causal pathological processes. The passage of time and the frequency with which recurrences are observed will decide whether such differentiation was justifiable and correct.

Treatment of segmental inflammatory colonic lesions also raises considerable problems for physician and for surgeon; the physician may tend, because of initial success, to treat cases medically for too long, allowing the rectum to become involved, rendering ileorectal anastomosis impossible. The surgeon may operate on patients with Crohn's disease or with non-specific enterocolitis who would probably have fared better with medical treatment. Search must therefore continue for clinical methods by which the pathological disease processes can be identified. The finding of typical giant-cell systems in rectal biopsy specimens and material from anal fistulæ which enables unrecognized Crohn's disease to be identified (Morson and Lockhart-Mummery, 1959) is a promising further field for investigation.

SUMMARY

1. A form of colitis exists which involves the more proximal parts of the colon but spares the rectum and distal colon in the first instance.

2. It may be due to three groups of diseases—true segmental ulcerative colitis, Crohn's enteritis, and other less well defined forms of ileocolitis. Clinically it is extremely difficult to distinguish these different lesions with confidence, as a rule, but pathological differentiation is usually possible.

3. Some of the clinical, radiological, and pathological features and diagnostic problems of segmental colitis are illustrated by a description of 15 patients who presented with this syndrome. They were part of a larger group of 114 cases with colitis seen jointly by us in Leeds between 1955 and 1958 inclusive.

4. Medical treatment may on occasions induce prolonged remission of symptoms of segmental colitis, as of ordinary forms of colitis, but it is important to remember the danger of distal progression

of the disease. If this should occur it may render impracticable the highly attractive operation of colectomy with ileosigmoidal or ileorectal anastomosis, which is possible in the great majority of cases, and, in our hands, has given excellent short- and medium-term results.

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REFERENCES

BARBOSA, J. DE C., BARGEN, J. A., and DIXON, C. F. (1945), *Surg. Clin. N. Amer.*, **25**, 939.

BARGEN, J. A. (1928), *Arch. Surg., Chicago*, **30**, 854.

— — (1930), *Ann. intern. Med.*, **3**, 335.

— — (1932), in *Colon, Rectum and Anus* (Rankin, F. W., Bargen, J. A., and Buie, L. A.). Philadelphia: W. B. Saunders.

— — (1947), quoted by CROHN and others.

— — and WEBER, H. M. (1930), *Surg. Gynec. Obstet.*, **50**, 964.

BOCKUS, H. L., ROTH, J. L. A., BUCHMAN, E., KALSER, M., STAUB, W. R., FINKELSTEIN, A., and VALDES-DAPENA, A. (1956), *Gastroenterologia, Basel*, **86**, 549.

BRANCH, C., and SLEDGE, C. B. (1955), *Gastroenterology*, **28**, 981.

BROOKE, B. N. (1954), *Ulcerative Colitis and its Surgical Treatment*. Edinburgh: Livingstone.

— — and COOKE, W. T. (1951), *Lancet*, **2**, 462.

BYWATERS, E. G. L., and ANSELL, B. M. (1958), *Ann. rheum. Dis.*, **17**, 169.

COOKE, W. T., and BROOKE, B. N. (1955), *Quart. J. Med.*, **24**, 1.

COUNSELL, P. B. (1956), *Brit. J. Surg.*, **44**, 276.

— — and DUKES, C. E. (1952), *Ibid.*, **39**, 485.

CROHN, B. B. (1949), *Regional Ileitis*. London: Staples Press.

— — and BERG, A. A. (1938), *J. Amer. med. Ass.*, **110**, 32.

— — GARLOCK, J. H., and YARNIS, H. (1947), *Ibid.*, **134**, 334.

HOFFBAUER, F. W., MCCARTNEY, J. S., DENNIS, C., and KARLSON, K. (1953), *Ann. intern. Med.*, **39**, 267.

KELLOCK, J. D. (1957), *Lancet*, **2**, 660.

KIRSNER, J. B., SKLAR, M., and PALMER, W. L. (1957), *Amer. J. Med.*, **22**, 264.

KLECKNER, M. S., STAUFFER, H. H., BARGEN, J. A., and DOCKERTY, M. B. (1952), *Gastroenterology*, **21**, 13.

LUMB, G. (1951), *Brit. J. Surg.*, **39**, 233.

— — and PROTHEROE, R. H. (1958), *Gastroenterology*, **34**, 381.

LYNN, D. H. (1945), *Int. Abstr. Surg.*, **1**, 269.

MANNING, J. H., WARREN, R., and ADI, A. S. (1955), *New Engl. J. Med.*, **252**, 850.

MORSON, B. C., and LOCKHART-MUMMERY, H. E. (1959), *Lancet*, **2**, 1122.

MOYNIHAN, B. G. A. (1907), *Edinb. med. J.*, **21**, 228.

NEUMAN, H. W., BARGEN, J. A., and JUDD, E. S. (1954), *Surg. Gynec. Obstet.*, **99**, 563.

— — and DOCKERTY, M. B. (1954), *Ibid.*, **99**, 572.

PAULLEY, J. W. (1958), *Lancet*, **2**, 959.

ROBSON, A. W. M. (1908), *Brit. med. J.*, **1**, 425.

WARREN, S., and SOMMERS, S. C. (1954), *J. Amer. med. Ass.*, **154**, 189.

WELLS, C. A. (1952), *Ann. R. Coll. Surg. Engl.*, **11**, 105.

WRIGHT, V., and WATKINSON, G. (1959), *Medicine*, **38**, 243.

VAN PATTER, W. N., BARGEN, J. A., DOCKERTY, M. B., FELDERMAN, W. H., MAYO, C. W., and WAUGH, J. M. (1954), *Gastroenterology*, **26**, 347.

ACUTE SOLITARY ULCERS AND ACUTE DIVERTICULITIS OF THE CÆCUM AND ASCENDING COLON

By K. LLOYD WILLIAMS

SENIOR SURGICAL REGISTRAR, CENTRAL MIDDLESEX HOSPITAL, LONDON

AT laparatomy for suspected appendicitis, one occasionally finds a normal appendix and a mass containing a palpable ulcer or diverticulum in the adjacent cæcum or ascending colon. Though rare, these conditions have aroused some interest, because of the difficulty in differentiating them from carcinoma and because of the speculation surrounding their aetiology.

Edwards (1954) described 10 patients suspected of appendicitis who, at operation, had a normal appendix and a mass in the cæcum. In 4 the cause was inflammation in a solitary cæcal diverticulum. In the other 6 cases the exact pathology was difficult to determine. They were thought to be either a solitary ulcer of the cæcum at the ileocæcal angle, or inflammation in a diverticulum.

It is not generally realized that inflammation of a solitary diverticulum can produce an ulcer (Fairbank and Rob, 1947), and though diverticulitis of the sigmoid has earned the pseudonym of 'left-sided appendicitis', diverticulitis of the cæcum is rarely entertained as a differential diagnosis of pain and tenderness in the right iliac fossa (Reid, 1951).

HISTORICAL

Acute simple ulcers of the cæcum were first described by Cruveilhier (1829). From then on sporadic cases were reported, until Cameron (1939) was able to review 42 cases, adding 1 case of his own. Since that time, further cases have been added by Barlow (1941), Rosser (1944), Cromar (1946), Blum (1947), Sangster (1949), Lipton and Reisman (1951), Watts (1955), Parker and Sergeant (1957). These solitary ulcers, presenting no specific pathological picture, appear to be uncommon, as no published series contains more than 3 cases, and only 68 cases were reported up to March, 1958. It is generally agreed that a solitary punched-out ulcer penetrating the muscle coats occurs in close proximity to the ileocæcal valve, often with an associated inflammatory mass. Most cases present in early adult life with a pre-operative diagnosis of appendicitis. Complications of peritonitis, hæmorrhage, and abscess formation are described and perforation is said to occur in 65 per cent of cases. Many stress the seriousness of the condition, Cameron quoting the surprisingly high mortality of 100 per cent in

unoperated cases and 40 per cent in those operated upon, in his series of 43 cases collected from the literature. Wilkie (1937), Rosser, and Cromar all report cases of solitary ulcer mimicking carcinoma.

Acute inflammation of a solitary diverticulum of the cæcum also appears to be rare, though being reported with increasing frequency. It was first described by Potier (1912). Bennett-Jones (1937) reported 20 cases, and Anderson (1947) was able to collect 91 cases and add 8 of his own. Further cases have been reported by Grace (1939), Hendtlass (1944), Gordon-Taylor (1939), Fairbank and Rob (1947), Byrne, Kallan, and Bassett (1950), Reid (1951), Unger (1953), Leichtling (1955), Parker and Sergeant (1957), Lauridsen and Ross (1952), making a total of 163.

In most cases an inflammatory mass is present in the cæcum close to the ileocæcal valve. It occurs in early adult life, and usually presents clinically as an acute appendicitis (84 per cent of Anderson's reported cases). Many stress the difficulty of differentiation from carcinoma at operation. Hæmorrhage, ulceration, perforation (which was present in 20 per cent of cases), abscess formation, and generalized peritonitis may occur. Fæcoliths were present in 50 per cent of cases.

The aetiology is generally held to be due to inflammation in a congenital diverticulum because of the young age-group and the failure to demonstrate other diverticula on barium enema.

PRESENT INVESTIGATION

Object.—The similarity of age-group, site, presentation, and complications of these two conditions prompts re-examination of cases presenting with a mass and ulcer in the cæcum in an endeavour to elucidate their possible aetiology. In addition, the results of 3500 consecutive barium-enema investigations have been analysed to determine the frequency and distribution of solitary diverticula of the large bowel.

Table I.—Symptoms and Signs

Case No.	1	2	3	4	5	6	7	8	9	10
Central pain	+		+					+	+	+
Tenderness in right iliac fossa	+	+	+	+	+	+	+	+	+	+
Rebound tenderness	+		+	+			+			+
Rectal tenderness	+		+							
Mass in right iliac fossa		+				+		+	+	
Vomiting										
Fœtor oris	+	+	+	+	+	+	+	+	+	+
Furred tongue	+	+	+	+	+	+	+	+	+	+
Temperature	99	99	100	97	99	100	99	98	98	99
Pulse-rate	100	100	80	90	90	120	90	80	84	100

Material.—Ten cases at St. Helier Hospital and the Central Middlesex Hospital during the past 7 years had operative findings of an ulcer surrounded by an inflammatory mass in the cæcum or ascending colon. All were diagnosed at one stage as acute simple ulcers. There were 6 females and 4 males. The oldest was 55 years and the youngest 23 years, with an average age of 40 years.

Clinical Findings.—Nine cases presented with histories and physical signs indistinguishable from

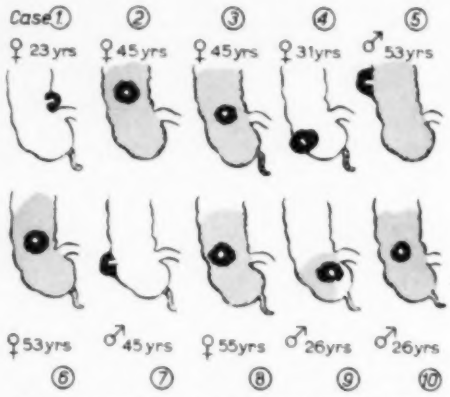

Fig. 347.—Showing site of mass and ulcer. Extent of operative procedure shown in stipple.

acute appendicitis (*Table I*). The tenth case (*Case* 2), a woman of 44 years who had had a previous appendicectomy, was first seen with symptoms and signs of cholelithiasis, which was subsequently confirmed by cholecystogram and later operation. A tender mass in the right iliac fossa was also noted and a barium enema showed deformity of the cæcum; no diverticula were visible in the colon and a radiological diagnosis of appendix abscess was made. At laparatomy, the mass in the ascending colon was thought to be neoplastic and a right hemicolectomy was later performed.

Table II.—Operative Findings

Case No.	1	2	3	4	5	6	7	8	9	10
Normal appendix	+	*	+	+	+	*	+	+	+	+
Œdema of cæcum	†	†	+	+	+	+	+	+	+	+
Mass	+	+	+	+	+	+	+	+	+	+
Ulcer	+	+	+	+	+	+	+	+	+	+
Enlarged mesenteric glands	+	+	+	+	+	+	+	+	+	+
Fæcolith									+	
Perforation										
Site of ulcer	M.†	P.	P.	A.	L.	P.	L.	L.	P.	P.

* *Cases* 2 and 6 had had previous appendicectomy.
† M. = Medial, P. = Posterior, A. = Anterior, L. = Lateral.
All ulcers were within 3 in. of the ileocæcal valve.

Surgical Findings.—At operation all patients, except *Cases* 2 and 6 (who had had a previous appendicectomy), were found to have a normal appendix. In every patient the cæcum or adjacent

FIG. 348.—*Case* 9. A man of 26 years presenting with symptoms and physical signs suggestive of acute appendicitis. At operation a mass was found in the cæcum with a normal appendix. The mass contained a fæcolith, and section of the ulcer left after dislodging the fæcolith was of non-specific ulceration.

ascending colon was œdematous and inflamed and contained a hard fixed mass, varying in size from a golf ball to an orange. An ulcer was invariably palpated in the centre of the mass by invagination of the opposite cæcal wall. Ulcers were on the posterior wall (6 cases), on the lateral wall (2 cases), on the medial wall (1 case), or on the anterior wall (1 case). All were within 3 in. of the ileocæcal valve and had raised indurated edges. They were 1 cm. or more in diameter, 1 to 2 cm. in depth, and admitted the tip of the index finger. Enlarged, firm, mesenteric glands were present in all cases (*Table II*).

Operative Diagnosis and Treatment.—In 5 cases (*Cases* 2, 3, 5, 6, and 8) a carcinomatous ulcer was diagnosed and a right hemicolectomy performed (*Fig.* 347).

In 5 cases (*Cases* 1, 4, 7, 9, and 10) an acute simple ulcer was diagnosed; 3 of these (*Cases* 1, 4, and 7) had

FIG. 349.—*Case* 8. Photomicrograph showing an inflamed diverticulum passing through the muscle coats with the mucosa almost intact and an acute inflammatory reaction surrounding it passing out into the sub-serosal fat. (× 3.)

FIG. 350.—*Case* 3. Photomicrograph showing inflammation in a diverticulum with normal mucous glands occurring deep to the muscle coats with surrounding non-specific inflammation. (× 3.)

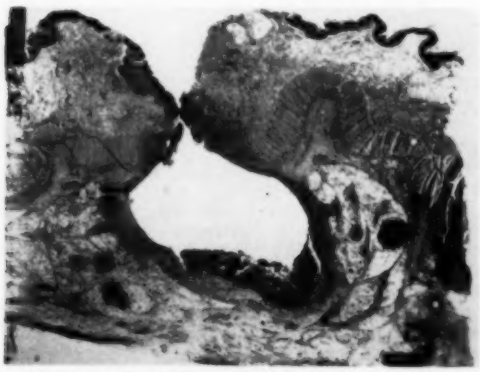

FIG. 351.—*Case* 6. Photomicrograph showing diverticulum passing through the muscle coats with an area of normal-looking mucosa in the base and inflammation spreading out into the sub-serous fatty tissue. (× 3.)

FIG. 352.—*Case* 5. Photomicrograph showing wide ulcer of the mucosa passing through the muscle coats with an inflammatory reaction passing out into the sub-serous fat. (× 3.) Some mucosa is visible deep to the muscle coats.

an appendicectomy; *Case* 4 had so much œdema and induration of the anterior cæcal wall that cæcostomy as well as appendicectomy was carried out. In *Case* 10 an acute simple ulcer was diagnosed and a right hemicolectomy performed.

In 1 case (*Case* 9) the cæcum was opened and a fæcolith the size of a marble was dislodged from the centre of the indurated mass, leaving an ulcer 1 cm. in depth and 2 cm. in diameter on the posterior wall of the cæcum, just above the level of the ileocæcal valve. This was considered a simple ulcer, and a wedge resection of the ulcer and the surrounding indurated area was carried out (*Fig.* 348).

Pathological Findings (*Figs.* 349–352).—Pathological material was available in 7 cases (6 hemicolectomy specimens and 1 wedge resection). Macroscopically, in all these cases there was a circular ulcer 1–1½ cm. in diameter and 1–2 cm. in depth in the centre of an indurated mass. The edges of the ulcer were œdematous and regular and the base contained slough and debris.

In 5 of these cases (*Cases* 3, 5, 6, 8, and 10) microscopy demonstrated ulceration in a diverticulum. In all of these, as is shown in the accompanying photomicrographs, some mucous epithelium with accompanying muscularis mucosa can be seen at a distance of about 5 or 7 mm. below the level of the main muscle coat. In all cases there is ulceration of the wall of the diverticulum. The mucous glands are in direct contact with the fatty serosa of the cæcum. Surrounding the diverticulum is an area of inflammatory reaction consisting of polymorphonuclear infiltration, blood, and fibrin.

In the remaining 2 cases (*Cases* 2 and 9) the microscopic picture was of an inflammatory ulcer of non-specific pathology. In one of these (*Case* 9, *Fig.* 348), where a fæcolith was displaced from the cæcal wall, the pathological report was as follows: "A small ulcer, 5 mm. in diameter, in the cæcal wall, 1 cm. in depth; the histology shows a deep ulcer of the gut wall, undermining the mucosa, with inflammatory changes extending far out into the serosal fat. The ulcer was lined by a broad layer of fibrinoid necrosis mixed with necrotic polymorphs and containing bits of fæcal matter. There were confluent hæmorrhages in the serosa and a few scattered normal-looking intestinal glands were found in spaces in the region of the serosal fat tissue." The pathologist thought that these were probably the products of an artificial displacement of normal mucous glands and that the picture was compatible with stercoral ulceration.

In all 7 cases it was obvious on macroscopic examination that the ulcer was not malignant, and all were diagnosed before histology as acute simple ulcers. The appendix was histologically normal in 8 cases.

Radiographic Findings.—Barium enema was performed post-operatively in 8 cases; in 5 no other diverticula were demonstrated in the large bowel. In 3 (*Cases* 3, 7, and 8), multiple diverticula were demonstrated.

Repeat barium enemas were performed on 6 cases and no change was demonstrated from their previous radiographs. *Cases* 4 and 7 had repeat barium enemas performed after an interval of 7 years, with no demonstrable change.

Case 2.—After 1 year showed no diverticula.

Case 3.—After 4 years showed multiple diverticula in transverse, descending, and sigmoid colon.

Case 4.—After 7 years showed no diverticula.

Case 5.—After 4 years showed no diverticula.

Case 7.—After 7 years showed 2 diverticula in transverse colon.

Case 8.—After 2 years showed multiple diverticula in transverse and sigmoid colon.

It is interesting to note that the patients showing multiple diverticula were all older than the average age of presentation—45, 45, and 55 years.

Progress.—There was no mortality. All cases received 1,000,000 units of penicillin and 1·0 g. of streptomycin daily for 5 days post-operatively. The 2 patients in whom simple appendicectomy alone was carried out were in hospital 7 and 11 days respectively and their course was similar to that of an acute appendicitis. *Case* 4, which had an appendicectomy and cæcostomy, was in hospital for 14 days. The hemicolectomies were in hospital 15, 25, 22, 26, 24, and 36 days.

Follow-up.—All except one of the cases (*Case* 9) have been followed up from 6 months to 7 years and in none of them has there been recurrence of symptoms or any abnormality to be detected on examination.

DISCUSSION

Acute inflammation of a solitary diverticulum of the cæcum is now a proven clinical entity (Bennett-Jones, 1937; Anderson, 1947; Lauridsen and Ross, 1952), but the aetiology of acute simple ulcers of the cæcum has remained an enigma. Cameron (1939) likened them to duodenal ulcers; Parker and Sergeant (1957) thought they were due to acute inflammation following some abrasion of the mucosa; Wilkie (1937) thought they were similar to gastric ulcers. Fox (1951), quoted by Lipton and Reisman (1951), suggested that solitary ulcers resulted from inflammation in a solitary diverticulum, with subsequent obliteration of the diverticulum, leaving an ulcer. This is apparently well substantiated by *Case* 9, where a fæcolith was displaced from an indurated mass in the posterior wall of the cæcum opposite the ileocæcal valve, leaving an ulcer (*Fig.* 348). Subsequent histological section showed non-specific ulceration, but with normal-looking intestinal mucous glands far out in the peri-cæcal fat and phagocytes containing ingested fæcal material. A fæcolith deeply embedded in the cæcal wall is most likely to have arisen in a diverticulum. Had this patient been operated upon after the fæcolith had been extruded, either into the bowel lumen or into the general peritoneal cavity, the diagnosis would probably have been that of a simple solitary non-specific ulcer of the cæcum.

The site of solitary ulcers close to the ileocæcal valve (Barlow, 1941; Cameron, 1939) supports a common aetiology with solitary diverticula. Lauridsen and Ross (1951) found that 80 per cent of 153 cases of inflamed solitary diverticula of the cæcum occurred within 1 in. of the ileocæcal valve. All of our cases occurred within 3 in. of the ileocæcal valve and 7 within 1 in.

Barlow pointed out that solitary ulcers occur in other parts of the large bowel, 16 per cent of 78 cases having occurred in the sigmoid. It has been shown

here that solitary diverticula occur in other parts of the bowel (*Figs.* 353–356) and 4 of 10 cases of solitary diverticula in 3560 barium enemas occurred in the upper sigmoid.

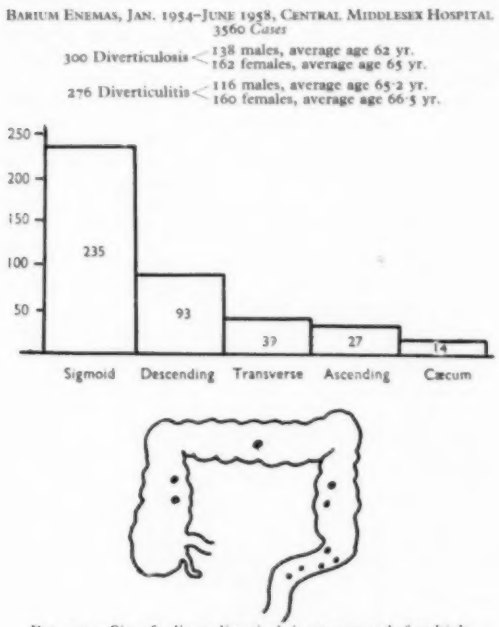

Fig. 353.—Site of solitary diverticula in 10 cases and of multiple diverticula in 290 cases. Average age incidence.

There is striking similarity of presentation, age-group, physical signs, and complications of solitary cæcal ulcers and inflammation of a solitary diverticulum of the cæcum. Cameron (1939) quotes the

Fig. 354.—Barium enema in a woman aged 49 years with a solitary diverticulum of the ascending colon.

Fig. 355.—Barium enema in a man aged 71 years with a solitary diverticulum of the descending colon.

Fig. 356.—Barium enema in a female aged 77 years with a solitary diverticulum of the upper sigmoid, containing a small fæcolith.

average age for cæcal ulceration as 37 years, and Anderson (1947) reports the average age for solitary diverticulitis as 39 years. Eighty-four per cent of diverticula and 80 per cent of simple ulcer of the cæcum present as acute appendicitis (Anderson; Cameron). Both conditions commonly result in a mass in the right iliac fossa and both may bleed, perforate, form local abscess, or produce generalized peritonitis.

Finally, it has been reported that acute diverticulitis of the cæcum can produce an ulcer (Fairbank and Rob, 1947). This is certainly supported by *Cases* 3, 5, 6, 8, and 10, where an ulceration was felt at operation, demonstrated in the macroscopic specimen, and on microscopy was shown to be inflammation in a solitary diverticulum.

In all cases reported here an ulcer was felt at operation, and the diagnosis, either at operation or on looking at the excised specimen, was that of acute simple ulcer. However, in the 7 cases where pathological material was available, all except 1 (*Case* 2) were proved to originate in an inflamed diverticulum. Of the 3 cases in which pathological material was not available, 2 had short histories of under 24 hours, and yet at operation a deep penetrating ulcer was felt, admitting the tip of the index finger; inflammation of a diverticulum is a more convincing explanation than inflammatory erosion occurring in such a short space of time.

It has been postulated that acute inflammation of a diverticulum can resolve spontaneously and may even produce its obliteration (Reid, 1951). *Cases* 1 and 7 had a simple appendicectomy and *Case* 4 an appendicectomy and cæcostomy; their post-operative courses were uneventful and subsequent barium enemas failed to demonstrate diverticula in the cæcum. They have subsequently been followed up for 6 months, 7 years, and 7 years respectively, without recurrence of symptoms.

The probability of misdiagnosis of inflammation of a cæcal diverticulum is very high, particularly if an ulcer is present—one-third of Anderson's 100 cases had hemicolectomy for carcinoma. Fairbank and Rob (1947) point out that their 2 cases were subjected to a hemicolectomy because they were thought to be neoplastic. After hemicolectomy the macroscopic specimen was thought to be an acute simple ulcer and it was only on serial microscopic section that diverticulitis was proved. This is confirmed in 4 of our 6 hemicolectomy specimens (*Cases* 3, 5, 6, and 8).

Diverticula rarely give rise to symptoms unless inflamed (Reid, 1951). It is probable that this inflammation is most commonly due to the presence of a fæcolith. This is substantiated by the findings of Lauridsen and Ross (1952), where fæcoliths were present in 50 per cent of their 53 collected cases of inflammation of a solitary diverticulum of the cæcum. A fæcolith was found in only 1 of these cases, and it seems possible that the ulceration in the remaining cases might have been produced by a fæcolith which was later extruded by the inflammatory process (*Fig.* 348). These cases are not truly representative of inflammation of diverticula, because their selection depended on the presence of an ulcer and a mass in the right iliac fossa. Hence, though ulceration occurred in all our cases, from a review of the literature it has not appeared to be a common complication of inflammation of a solitary diverticulum.

Once inflammation has occurred, the process may follow one of several paths. Thus, a diverticulum can form a hard inflammatory mass mimicking carcinoma, perforate, ulcerate, or bleed, form a fistula or an abscess, and once the cycle of inflammatory changes has occurred, the primary pathology may be obliterated, leaving an ulcer with no specific pathology, a phlegmonous cæcitis, or a chronic infective granulomatous mass. It seems probable, as pointed out by Reid (1951), that some cases of diverticulitis have in the past been ascribed to subacute or resolving appendicitis and some abscesses drained in the belief that they were of appendicular origin. Perhaps some cases of acute ileocolitis owe their favourable prognosis to an unsuspected inflammation of a diverticulum, and perhaps also some cases labelled 'ileocæcal tuberculosis' owe their uninterrupted recovery to a similar underlying pathology.

The question whether these diverticula are congenital or acquired has raised some interest and speculation. Usually they have been described as solitary; however, in this series the younger age-group tended to have solitary diverticula and the older ones multiple diverticula throughout the bowel. In all the cases the diverticula were of the type which is described as acquired; namely, they consisted of mucosa with surrounding muscularis mucosa appearing well out in the cæcal fat at some distance from the longitudinal and circular muscles of the bowel wall. It is, however, interesting to note that in those cases in which repeat barium enemas were carried out at an interval of some years, no further diverticula had developed, and it seems permissible to argue that their origin depends upon some congenital defect in the wall of the bowel, allowing a herniation of the mucosa, and this is substantiated by the fact that they do not follow the pattern of progressive diverticulosis.

Diverticula of the cæcum are rare. Oschner and Bargen (1935), reviewing 151 cases of uncomplicated diverticulosis of the colon, found that 2 per cent of the cases showed diverticula occurring in the right half of the colon. It was found, in analysing the barium-enema figures for a 4½-year period at the Central Middlesex Hospital, that out of 290 cases having multiple diverticula in the large bowel, only 14 had diverticula in the cæcum, and of these 14, 11 had multiple diverticula throughout the whole of the large bowel (*Fig.* 353).

Diagnosis.—It is unlikely that differentiation will be made from acute appendicitis pre-operatively (Anderson, 1947; Fairbank and Rob, 1947) unless an appendicectomy has previously been performed. A mass is commoner in diverticulitis than in appendicitis and vomiting appears to be an infrequent finding; this is confirmed in these cases and in those of Lauridsen and Ross (1952). It also seems to be less common to have a shift of pain, but this occurred in 4 of the cases.

It is obviously important to differentiate diverticulitis from carcinoma at operation. Lauridsen and Ross point out that in the 68 cases in their series where diverticulectomy or simple excision was performed the mortality was 1·6 per cent; but in the 39 cases where a radical hemicolectomy was carried out because the lesion was thought to be

carcinomatous, the mortality was 11·4 per cent. They point out that a fæcolith (present in 50 per cent of their 53 cases) may occasionally be palpated through the œdematous ostium of the diverticulum. They also state that straight radiographs or barium enema may facilitate diagnosis by demonstrating a fæcolith here, though the operative diagnosis was carcinoma, on subsequent macroscopic examination it was obvious that the ulcers were benign. Unger (1953) suggests cæcostomy as a valuable manœuvre to see the mucosal side of the lesion, when an inflammatory diverticulum will be recognized. Though this would

FIG. 357.—*Case* 10. A man of 26 years who presented clinically as acute appendicitis at operation was thought to have an acute simple ulcer and a right hemicolectomy was performed. The macroscopic appearance was thought to be an acute simple ulcer. Histology demonstrated diverticulitis.

or diverticulum, but the latter investigation will seldom be contemplated in cases presenting as acute appendicitis. Though differentiation from carcinoma is difficult, particularly if an ulcer is present (Fairbank and Rob, 1947; *Cases* 3, 5, 6, and 8), it should not prove impossible. Carcinoma of the cæcum presents rarely as an emergency (usually with an obstructed inflamed appendix, or as an intestinal obstruction due to involvement of the ileocæcal valve, or more rarely as a perforation). The inflamed diverticulum does not cause obstruction, nor does it involve the appendix. The mass in a diverticulum appears to be part of the bowel wall and the thickening is greater outside than inside, and the ulcer is deeper, more regular, and more punched out than that of a carcinoma (*Figs.* 348, 357). The absence of anæmia, the age of the patient, the typical site, and the shortness of history are all valuable pointers to the diagnosis of diverticulitis, but perhaps the greatest aid of all is an awareness of the condition of inflammation of a solitary diverticulum of the cæcum.

It is interesting that in both of the cases reported by Fairbank and Rob (1947) and in those reported undoubtedly provide the diagnosis, it would seem on theoretical grounds to be unjustifiable because of the increased risk of implantation and dissemination, should it prove to be a carcinoma.

Treatment.—If the diagnosis is obvious, then diverticulectomy or wedge resection should be performed in suitable cases. Extensive inflammation and induration will usually recede with drainage and antibiotics. If it does not do so, then it will allow resection at a later date when the patient has been adequately prepared. The presence of perforation will require closure and drainage or cæcostomy. If, at operation, the differentiation from carcinoma is impossible, the approach should be conservative. A subsequent barium enema may establish the diagnosis and the patient can then be adequately prepared for a definitive resection.

The high mortality quoted in the literature probably derives from the fact that the cases occurred before the common use of antibiotics and intravenous therapy. There were no deaths in this series, though 3 cases had no more than appendicectomy. Parker and Sargeant (1957) had similar findings in their cases where local resection was carried out.

SUMMARY

1. Ten cases presenting at operation with a mass and an ulcer in the cæcum are described.

2. Nine cases were clinically indistinguishable from acute appendicitis.

3. Five were proved to be inflammation in a diverticulum of the cæcum and 4 further cases were probably inflammation in a solitary diverticulum.

4. The presence of ulceration occurring in inflammation of a diverticulum is described.

5. The literature is reviewed and the similarity of presentation of acute ulcers of the cæcum and inflammation of a solitary diverticulum of the cæcum is demonstrated and evidence in favour of a common aetiology is presented.

6. An attempt is made to describe the points of differentiation from a carcinomatous ulcer.

7. A conservative approach is advocated.

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REFERENCES

ANDERSON, L. (1947), *Surgery*, **22**, 479.
BARLOW, D. (1941), *Brit. J. Surg.*, **28**, 575.
BENNETT-JONES, M. J. (1937), *Ibid.*, **25**, 66.
BLUM, L. (1947), *Surg. Clin. N. Amer.*, **27**, 355.
BYRNE, J. J., KALLAN, A. C., and BASSETT, A. A. (1950), *J. Amer. med. Ass.*, **144**, 823.
CAMERON, J. R. (1939), *Brit. J. Surg.*, **26**, 426.
CROMAR, C. D. L. (1946), *Amer. J. dig. Dis.*, **13**, 230.
CRUVEILHIER, J. (1829), *Anatomie pathologique du corps humain*. Paris: J. B. Baillière.
EDWARDS, H. C. (1954), *Ann. R. Coll. Surg. Engl.*, **14**, 371.
FAIRBANK, T. J., and ROB, C. G. (1947), *Brit. J. Surg.*, **35**, 105.
FOX, L. (1951), quoted by LIPTON and REISMAN.
GORDON-TAYLOR, G. (1939), *Proc. R. Soc. Med.*, **32**, 896.
GRACE, A. J. (1939), *Brit. J. Surg.*, **26**, 200.
HENDTLASS, R. F. (1944), *Brit. med. J.*, **2**, 309.
LAURIDSEN, J., and ROSS, F. P. (1952), *Arch. Surg., Chicago*, **64**, 320.
LEICHTLING, J. J. (1955), *Gastroenterology*, **29**, 453.
LIPTON, S., and REISMAN, E. D. (1951), *Ann. Surg.*, **134**, 279.
OSCHNER, H. C., and BARGEN, J. A. (1935), *Ann. intern. Med.*, **9**, 282.
PARKER, R. A., and SERGEANT, J. C. B. (1957), *Brit. J. Surg.*, **45**, 19.
POTIER, F. (1912), *Bull. Soc. Anat. Paris*, **87**, 29.
REID, D. R. K. (1951), *Brit. J. Surg.*, **39**, 76.
ROSSER, C. (1944), *Ann. Surg.*, **119**, 377.
SANGSTER, A. H. (1949), *Brit. J. Surg.*, **36**, 331.
UNGER, H. M. (1953), *Amer. J. Surg.*, **85**, 780.
WATTS, G. T. (1955), *Postgrad. med. J.*, **31**, 414.
WILKIE, D. (1937), *Surgery*, **1**, 655.

PRIMARY MALIGNANT LYMPHOMA OF THE ALIMENTARY TRACT

BY J. G. AZZOPARDI AND T. MENZIES

FROM THE DEPARTMENTS OF PATHOLOGY AND SURGERY, THE HAMMERSMITH HOSPITAL AND POSTGRADUATE MEDICAL SCHOOL OF LONDON

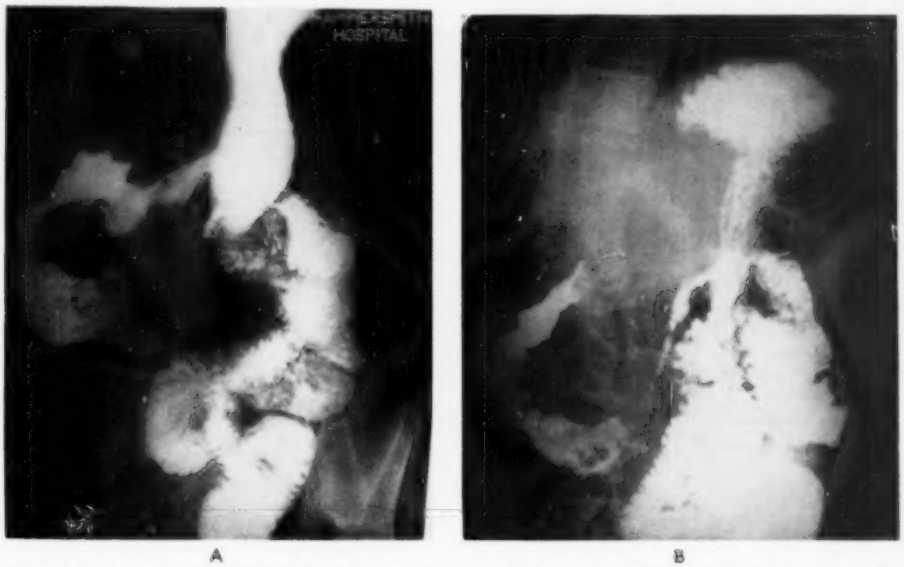
PRIMARY malignant lymphoma of the alimentary tract has achieved an important place in the North American literature during the last twenty years. It is not certain whether this is due to increased awareness of and interest in the disease or to a genuine increase in its frequency. No attempt is made here to review the earlier literature already reviewed by Ullman and Abeshouse (1932) and Frank, Miller, and Bell (1942). In the British literature, however, malignant lymphoma of the gastro-intestinal tract has received scant attention, and the purpose of this paper is to furnish data on 20 cases. The clinical and operative diagnosis is discussed and attention is focused on the factors affecting prognosis.

The material consists of 10 cases from the surgical files of Hammersmith Hospital, 1 operated on elsewhere by one of us, and 9 reported by courtesy of generous colleagues who have allowed us to use their material. All the patients presented with symptoms eventually found to be caused by malignant lymphoma of the gastro-intestinal tract. Those with peripheral or mediastinal lymphadenopathy or with hepatosplenomegaly are excluded. In *Case* 16 there was autopsy evidence of splenic involvement as well, but it is retained because of the unusual clinical presentation. Malignant lymphoma of the gastro-intestinal tract first diagnosed at autopsy is excluded. Finally, we have studied pathological material from a number of other cases which are excluded because of lack of clinical data.

The clinicopathological features of the twenty patients are detailed in *Table I*. Two of them have been previously reported (Bresnihan and Jones, 1953; O'Beirn, 1955).

There were 12 male and 8 female patients with an age range of 11–83 years. The average age was 52 years, but, more significant, 4 of 20 patients were under the age of 30 years. The duration of symptoms before seeking medical advice varied between 2 days and 18 months, excluding one patient (*Case* 1) whose 5-year history is of doubtful significance. In those with gastric lesions, the short history of epigastric pain or discomfort with or without anorexia, vomiting, and loss of weight usually suggested carcinoma. In contrast (*Case* 1), the longer history and relief of pain with alkalis was suggestive of peptic ulceration. One patient (*Case* 5) presented with generalized peritonitis due to perforation of an ulcer on the greater curve. In intestinal disease symptoms were

equally non-specific. Colicky abdominal pain with or without vomiting pointed to small intestinal obstruction in some instances; in others the vague symptomatology could equally well have been due to a gastric neoplasm. Three patients had perforation into the general peritoneal cavity. One (*Case* 11) had



A B

FIG. 358.—*Case* 13. Radiographic appearances. A, Note extensive infiltration of duodenal wall producing marked deformity and rigidity. B, Note multiple smooth filling defects. The whole appearance suggests neoplasia, but is too extensive for carcinoma.

FIG. 359.—*Case* 16. Grossly thickened gastric rugæ with brain-like appearance on mucosal aspect.

episodes of melæna and is the only patient in this series who showed frank bleeding. Another (*Case* 20) presented with symptoms suggestive of acute appendicitis.

On examination, a palpable abdominal mass was present in a little less than half of the patients. In those with generalized peritonitis muscular rigidity would have precluded the detection of any otherwise palpable mass. In many cases no barium studies had been carried out; this was especially true of those with intestinal lymphomata. This category includes patients with acute perforation, one simulating acute appendicitis and some in whom there was considered to be sufficient clinical indication for operative intervention without waiting for radiological studies. Where the disease involved the stomach, barium-meal examination usually suggested carcinoma of the pyloric region or greater curvature. In two instances the appearances indicated peptic ulceration with pyloric stenosis. In one of our own patients (*Case* 13) there were multiple filling defects in the duodenum, regarded as being suggestive of polyposis. On no occasion in this series was a radiological diagnosis of malignant lymphoma made, but on reviewing the films in *Case* 13 the radiologist considered that a tentative diagnosis of lymphoma was justifiable (*Fig.* 358). Thus, while radiological studies usually

FIG. 360.—*Case* 3. Low-power view of ulcerated gastric tumour. The tumour mass has expanded the submucosa while the muscle coat is intact. H. and E. (×2·7.)

Table I.—CLINICOPATHOLOGICAL FEATURES OF

CASE NO.	AGE (years)	SEX	DURATION OF SYMPTOMS	PRESENTING SYMPTOMS	PALPABLE ABDOMINAL MASS	X-RAY EXAMINATION	Hb Per cent	W.B.C. Per c.mm.
1	47	M.	5 yr. 2 mth.	Intermittent bouts of indigestion. Aching pain in right hypochondrium related to food and relieved by alkali	+	Large filling defect in pyloric antrum. Gross widening of duodenal loop with involvement of mucosa in first part of duodenum	91	5000
2	69	M.	4 mth.	Vomiting, epigastric pain, and abdominal distension. Loss of weight and constipation	–	Persistent deformity of pylorus suggestive of duodenal ulcer with pyloric stenosis	113	9000
3	29	M.	18 mth.	Epigastric pain, vomiting, and weight-loss	+	Ulceration in pyloric antrum with multiple filling defects very suggestive of carcinoma	95	Not done
4	45	M.	1 yr.	Indigestion not relieved by alkalis and vomiting	–	Pyloric obstruction suggestive of peptic ulcer	72	Not done
5	60	F.	1 wk.	Pain in left iliac fossa which progressed to symptoms of generalized peritonitis	–	Not done	Not done	Not done
6	70	F.	4 mth.	Epigastric pain not related to food or relieved by alkalis. Weight-loss	+	Large pyloric filling defect thought to be carcinoma	92	6000
7	58	F.	4 mth.	Heaviness in epigastrium not related to food. Weight-loss	–	Greater curve gastric ulcer opposite incisura angularis	82	Not done
8	59	M.	3 mth.	Epigastric discomfort and anorexia	–	Filling defect on greater curve suggestive of carcinoma	Not done	8200
9	70	F.	4 mth.	Epigastric pain, vomiting, and anorexia	+	Large greater curve filling defect suggestive of carcinoma	75	Not done
10	60	M.	3 mth.	Epigastric pain not related to food, with some vomiting. Some weight-loss	–	Barium meal suggested carcinoma of the stomach on greater curvature. Colon not involved	66	Not done
11	56	M.	1 mth.	Colicky abdominal pain and vomiting. Two episodes of melæna	+	Large, irregular filling defect in fundus of stomach. Normal duodenum	51	Not done
12	26	M.	3 mth.	Indigestion and central abdominal pain not related to food. Acute perforation in medical ward	–	Normal barium meal	95	20,000 Neutrophils 74 per cent Lymphocytes 19 per cent
13	56	F.	1 yr.	Recurrent attacks of vomiting and flatulence. Weight-loss	–	Multiple filling defects in duodenum, suggestive of polyposis. Narrowing of fourth part of duodenum	67	6000
14	62	M.	3 mth.	Vague dyspepsia, not related to food. Acute perforation at work	–	Not done	95	5000
15	59	M.	1 yr.	Attacks of colicky abdominal pain and numbness of left leg	–	Doubtful duodenal abnormality	Not done	Not done
16	60	M.	9 mth.	Borborygmi and anorexia. Weight-loss. Severe colicky abdominal pain	+	Not done	84	10,000
17	51	F.	1 yr.	Intermittent colicky pain in right iliac fossa with constipation. Marked weight-loss	+	Not done	37	17,500 25 per cent eosinophils
18	83	F.	3 d.	Acute generalized abdominal pain with vomiting. Acute perforation	–	Not done	72	Not done
19	18	M.	6 wk.	Heavy feeling in lower abdomen. Irregularity of bowel habit for 1 month	+	Not done	Not done	Not done
20	11	F.	2 d.	Vague pain in right iliac fossa with vomiting	–	Not done	Not done	Not done

20 Cases of Primary Malignant Lymphoma

Gross Pathological Findings	Microscopical Type	Regional Node Metastases	Treatment	Subsequent Progress
Tumour 10 × 6 cm. involving posterior wall and lower part of stomach, adherent to and infiltrating pancreas and transverse mesocolon	Reticulosarcoma	+	Pancreatico-duodenectomy, partial gastrectomy, and resection of middle portion of transverse colon. Post-operative deep X-ray therapy	Recurrent mass in abdomen 14 mth. after operation. Died 16 mth. after operation
Sleeve of stomach 2·3 cm. on greater curve and 15 cm. on lesser curve. Tumour nodule in the submucosa of the pylorus 13 × 18 mm.	Hodgkin's disease	–	Partial gastrectomy	Died 3 yr. after operation. Autopsy showed no recurrence, and death due to pulmonary infection
Butterfly-shaped ulcer extending from pylorus for 8·5 cm. along lesser curve	Reticulosarcoma	–	Partial gastrectomy	Alive and well 7 yr. 3 mth. after operation
Prepyloric gastric ulcer 1·5 cm. in diameter which looked benign. Enlarged regional lymph-nodes up to 2 cm. diameter	Reticulosarcoma	Not known	Partial gastrectomy. Post-operative deep X-ray therapy	Alive 8 mth. after operation, but has symptoms of extradural cord compression—this has been confirmed by myelogram
Large perforated greater curve gastric ulcer, 3·5 cm. diameter with rolled edges	Reticulosarcoma	–	Partial gastrectomy	Alive 2 yr. after operation, but has ophthalmoplegia and ptosis. Radiograph of skull shows no abnormality
Large greater curve gastric ulcer, 17·5 cm. in diameter and adherent to transverse colon	Reticulosarcoma	+	Partial gastrectomy with resection of middle one-third of transverse colon in continuity	Alive and well 5 yr. 9 mth. after operation
Thickened plaque, 5 cm. diameter on greater curve. No ulceration of mucosa	Reticulosarcoma	–	Partial gastrectomy	Alive and well 7 yr. after operation
Polypoid excrescence 3 × 2 cm. on greater curve of stomach	Reticulosarcoma	Not known	Wedge resection of lesion	Died 4 yr. after operation. Autopsy showed no recurrence and death due to cerebrovascular accident
Infiltrative lesion 13 × 8 cm. on greater curve extending on to anterior and posterior surfaces of stomach and on anterior surface reaching lesser curve. Slight ulceration of mucosa	Reticulosarcoma	+	Partial gastrectomy	Alive and well 3 mth. after operation
Larger ulcer on greater curve 3·2 × 2·8 cm. in diameter with a raised hard rolled edge	Small-cell lymphosarcoma	Not examined	Partial gastrectomy in continuity with 12 cm. of transverse colon	Alive and well 1 mth. after operation
Two-thirds of stomach wall involved in rubbery thickening up to 1·5 cm. thick. Multiple similar but smaller lesions involving small bowel from pylorus to terminal ileum	Reticulosarcoma	Not known	Ileotransverse colostomy followed 3 mth. later by laparotomy and biopsy	Died 5 mth. after first operation
22 cm. of jejunum with stricture at centre. Perforation on antimesenteric border at level of stricture. Ulcer 4 cm. long proximal to perforation, involving whole circumference of bowel	Reticulosarcoma	–	Resection of lesion and end-to-end reconstitution	Alive and well 2 yr. after operation
3 cm. biopsy of jejunum showing hypertrophy of mucosa and submucosa. Lymph-node biopsy	Giant-follicle lymphoma	–	Gastrojejunostomy and biopsy of jejunum. Post-operative deep X-ray therapy	Alive and well 4 yr. 5 mth. after operation
60 cm. upper jejunum with a thickened œdematous lesion showing perforation and dilatation of the lumen	Reticulosarcoma	–	Resection of lesion and end-to-end reconstitution	Alive and well 9 yr. after operation
Large tumour of jejunum to which several loops of bowel were adherent. Whole mass adherent to bladder	Reticulosarcoma	–	10 ft. of upper small bowel with adherent portion of bladder excised. End-to-end reconstitution and repair of bladder. Deep X-ray therapy for recurrence	Recurrent mass in left iliac fossa 2 mth. after operation treated by radiotherapy. Died in cachectic state 8 mth. after operation
Thickening of upper ileum, 5 cm. long, involving two-thirds of circumference. Rubbery mass of mesenteric nodes	Small-cell lymphosarcoma	+	Patient moribund. Laparotomy under local anæsthesia—excision of accidentally perforated ileal loop	Died 7 hr. after operation. Autopsy showed generalized submucosal thickening of stomach and duodenum and involvement of mesenteric lymph-nodes and spleen
Three loops of terminal ileum showing separate thick plaques involving whole circumference of bowel	Hodgkin's sarcoma	+	Right hemicolectomy with resection of 60 cm. of terminal ileum	Developed recurrent mass in right iliac fossa 6 wk. after operation, and died 3 mth. after operation
Large 25-cm. lesion of terminal ileum, necrotic adherent to anterior abdominal wall and perforated. Bowel wall thickened up to 1·5 cm.	Lymphoblastic lymphosarcoma	+	Resection of 140 cm. of ileum with end-to-end reconstitution	Died of peritonitis 2 d. after operation
Large ulcerating mass in cæcum penetrating to the serous coat	Reticulosarcoma	–	Right hemicolectomy. Deep X-ray therapy for recurrence	2 mth. after operation developed recurrent nodule in scar. Treated by excision followed by radiotherapy. Alive and well 15 yr. 3 mth. after first operation
Rounded submucous nodule 2·5 cm. diameter, projecting into cæcum	Lymphoblastic lymphosarcoma	Not examined	Right hemicolectomy	Alive and well 6 yr. 9 mth. after operation

suggested the presence of a neoplasm, they gave no indication of its true nature. The type of gastric involvement shown in *Fig.* 359 is reputed to have a diagnostic radiological picture, but unfortunately no radiographic studies were carried out. Most

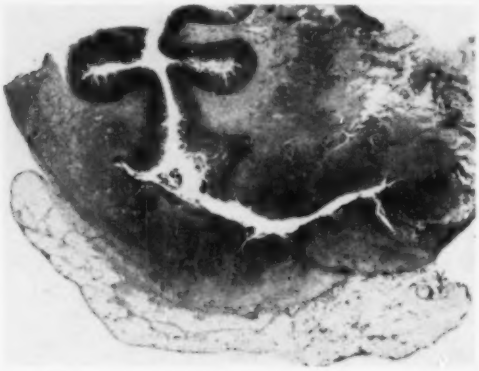


FIG. 361.—*Case* 14. Infiltrative type of tumour causing aneurysmal bulge of intestinal wall weakened by neoplastic infiltration. H. and E. (×2·7.)

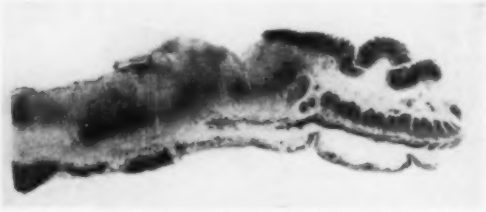


FIG. 362.—*Case* 12. Ulcerating infiltrative lesion. Note destruction of muscle coat and relatively circumscribed tumour edge. The dark material on the peritoneal surface is fibrin. H. and E. (×3·4.)

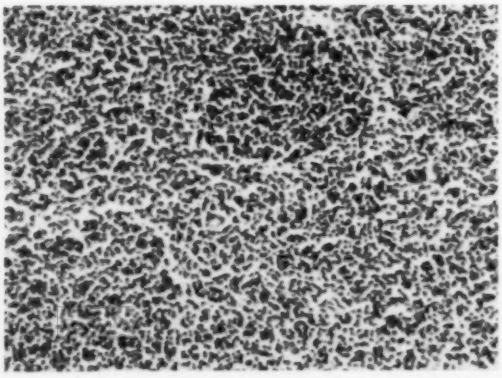


FIG. 364.—*Case* 16. Small-cell lymphosarcoma with traces of a follicular pattern. H. and E. (×150.)

patients had a normal hæmoglobin or were only mildly anæmic. Two notable exceptions were the patient with multiple lesions (*Case* 11) and the one with Hodgkin's sarcoma of the ileum (*Case* 17); the former was known to have had melæna, and in the latter fæcal occult blood-tests were repeatedly positive. The total white blood-cell count was usually normal, apart from a polymorph leucocytosis due to peritonitis (*Case* 12). An interesting finding was leucocytosis with gross eosinophilia in Hodgkin's sarcoma of the ileum (*Case* 17). Fæcal occult blood-examinations were positive in 3 of 6 patients tested.

At laparotomy the diagnosis of the true nature of the condition proved equally difficult. Most of the gastric lesions were regarded as carcinoma, while in *Case* 4 the surgeon thought he was dealing with a benign peptic ulcer. On only one occasion (*Case* 12) was a tentative diagnosis of malignant lymphoma made by one of us at operation; in retrospect, greater familiarity with the disease process might have led to the true diagnosis being suspected also in four others (*Cases* 11, 13, 16, and 17).

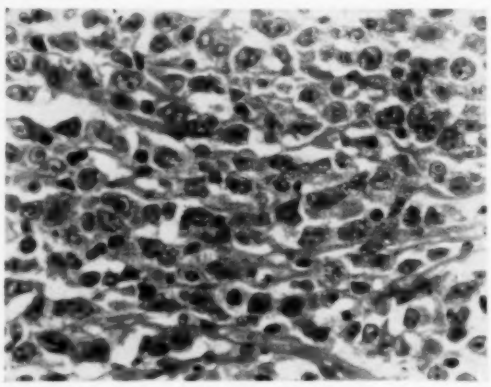


FIG. 363.—*Case* 12. Reticulosarcoma of jejunum. H. and E. (×364.)

In 10 patients the stomach was involved, in 6 the small intestine; in 2 both stomach and small intestine were affected, while in 2 the cæcum was the seat of disease. No tumours distal to the cæcum were encountered in this series. Three patients had multiple lesions. Of those involving the stomach, ulcerating tumours (*Fig.* 360) were frequent, but sometimes the infiltrative type produced a diffuse, fleshy thickening of the stomach wall (*Cases* 11 and 16; *see also Fig.* 359.) Infiltrating tumours were common in small intestine (*Figs.* 361, 362). Histologically, 13 of the lesions were classified as reticulosarcoma (*Fig.* 363), 4 as lymphosarcoma (*Fig.* 364), 2 as Hodgkin's disease (*Fig.* 365), and 1 as giant-follicle lymphoma. In 6 out of 16 specimens there was microscopical evidence of regional node involvement. The surgical impression of invaded lymph-nodes was often not confirmed histologically.

Curative resection was attempted in the 10 lesions involving the stomach only, in 5 of 6 involving the small intestine, and in both cæcal tumours. There was no attempt at surgical extirpation in the patient with duodenal involvement (*Case* 13) or in the two with combined gastric and intestinal lesions. The two latter died of their disease, while the former is alive and well four and a half years after a short-circuit operation followed by deep X-ray therapy.

Of the ten patients with gastric lesions, 3 are alive and well $5\frac{3}{4}$–$7\frac{1}{2}$ years after operation, 2 died of other diseases 3 and 4 years after operation with no evidence of recurrence at necropsy, 2 are alive and well after a recent operation, 2 are living probably with recurrent disease in other sites, and 1 died of his disease. Of 5 with tumours of the small intestine submitted to curative surgery, 2 are alive and well 2 and 9 years after operation, 1 died of post-operative peritonitis, and 2 died of their disease within a few months. Of the 2 with cæcal tumours, both are living and well $6\frac{3}{4}$ and $15\frac{1}{4}$ years after resection.

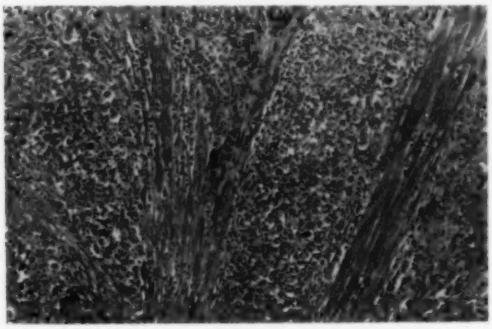


FIG. 365.—*Case* 2. Pleomorphic cellular infiltration and fibrous tissue increase in Hodgkin's disease of stomach. H. and E. (×105.)

FIG. 366.—*Case* 2. Submucosal pyloric nodule with microscopical appearances of Hodgkin's disease (*see Fig.* 365).

There are 6 5-year survivors among 11 potential survivors, but when considering only those submitted to curative surgery, there are 6 5-year survivors among 9 possibles. In this small series the patients with gastric and cæcal lesions fared better than those with disease of the small intestine.

DISCUSSION

Diagnosis.—Males outnumber females by about 2 to 1. The average age at the time of presentation, in published cases, is about 48 years, which is a few years younger than the average age in carcinoma of the stomach. This is attributed to the relatively large number of young patients who are affected. The gastric lymphomata usually present with a picture suggestive of carcinoma (*Case* 9) or peptic ulceration (*Case* 1). The intestinal lymphomata commonly give rise to the symptoms of bowel obstruction, usually chronic, but occasionally acute. Sometimes a lesion anywhere in the gastro-intestinal tract presents to the surgeon because of acute perforation. Rarely, a malabsorption syndrome with steatorrhœa is a prominent feature (Ingelfinger, 1957). The duration of symptoms before seeking medical advice may vary widely. There is usually some loss of weight, but apart from this most patients enjoy reasonably good health. Anæmia is absent or only mild in degree. Only one of our patients gave a history of frank bleeding, and it is the experience of Faulkner and Dockerty (1952) and Marshall and Meissner (1950) that hæmatemesis and melæna are uncommon findings. Exceptions to this are reported by McSwain and Beal (1944) and Elliott and Wilson (1952). Fæcal occult blood-tests are often positive. White-cell counts are usually normal or only slightly raised. Exceptions to this are our patient (*Case* 17) and one reported by Burman and Van Wyk (1956). In disease affecting the small intestine more than half the patients are said to have a palpable mass (Faulkner and Dockerty). Radiological examination nearly always reveals or suggests a gastric neoplasm. When the disease involves the intestine, symptoms usually justify barium meal or enema unless an acute surgical emergency prevents such procedures being carried out. Negative results in these investigations should focus attention on the small bowel, and a barium follow-through is then indicated. In the presence of obstruction, Fraser (1945) recommends a special radiological technique. These investigations often indicate the presence and location of a neoplasm, but only rarely suggest its true nature (Lame, Velat, and Custer, 1954). Only the diffuse type of gastric lymphosarcoma produces the reputedly classic, but not often seen, radiological picture with giant mucosal folds, and this in turn has to be differentiated from hypertrophic gastritis. Even at laparotomy the true nature of the neoplastic process is easily missed. It is less generally recognized that in the predominantly ulcerative type of lesion, particularly with perforation, the very existence of a neoplasm may not be detected at operation. The possibility of malignant lymphoma should be borne in mind when dealing with plaque-like or annular infiltrative lesions of the bowel, single or multiple, especially if associated with perforation or aneurysmal dilatation of the bowel, with diffuse gastric lesions of rubbery rather than scirrhous consistency, with intestinal perforations in unusual locations, with single or multiple ulcerations in the small bowel without apparent cause, with extensive or multiple gastric lesions in relatively fit patients, and with neoplastic bowel lesions in younger age-groups. In all cases of apparently inoperable gastro-intestinal malignant disease a biopsy specimen is essential to determine the histological nature of the tumour, as some encouragingly good results have been obtained by surgical and radiotherapeutic treatment of even advanced cases of malignant lymphoma of the alimentary tract.

Pathology.—The lymphoma takes the form of an infiltrative plaque or polypoid excrescence; sometimes, especially in the stomach, it forms an ulcerated

mass or an ulcer of macroscopically benign appearance. By the time the patient comes to operation the mass may be of considerable size. The infiltrative type may involve a large part of the stomach and occasionally may diffusely affect the gastric wall to produce giant rugæ simulating cerebral convolutions (*see Fig.* 359); a similar appearance has been noted in the rectum (Winkelstein and Levy, 1943). Where gastric involvement is less extensive, some lesions show involvement predominantly of submucosa, with little or no encroachment on mucosa or muscularis and insignificant ulceration (*Case* 9). In the bowel it may produce a thick, rigid segment like a piece of garden hose, with a lumen which may be rather narrowed but is sometimes of normal calibre or even dilated in the so-called aneurysmal variety (*see Fig.* 361). This dilatation is the result of muscle destruction by tumour cells and the absence of the dense fibrous reaction which produces the typical contraction in carcinoma. For the same reason the diffuse type of gastric lymphoma does not result in the contraction associated with the leather-bottle stomach. The tight annular constricting lesion, so frequent in carcinomata, is uncommon in lymphomata, though obstructive symptoms, acute or chronic, may result from intussusception associated with polypoid lesions, from kinking and adhesions of affected loops, and from interference with peristalsis by the neoplastic infiltration. Many of the ulcerated gastric lesions do not differ significantly from carcinoma on naked-eye examination. Multiple ulcerated masses should make one suspect malignant lymphoma. A primarily ulcerative intestinal lesion is less common than an infiltrative one, but is likely to give rise to clinical problems of some complexity, since perforation of such a lesion may occur in the absence of naked-eye evidence of tumour (Irvine and Johnstone, 1955). Sinus formation in the bowel wall may result and even microscopically neoplastic cells may be scanty in these necrotizing varieties. The combination of muscle destruction, tumour necrosis, and paucity of fibrosis contributes to the development of perforation. The frequency of this complication in gastro-intestinal lymphoma has been variably estimated by different authors. According to Chont (1941) perforation is exceedingly rare, while nearly half the cases had perforations in Irvine and Johnstone's material. While in the larger American series the perforation rate is in the region of 3–4 per cent (Usher and Dixon, 1943; Faulkner and Dockerty, 1952), in the combined British series of Skrimshire (1955), Irvine and Johnstone, and the present authors, 17 out of 61, or 28 per cent, perforated into the peritoneal cavity. It remains to be seen with the collection of further data whether or not this trend towards a national difference is maintained. Individual case reports dealing with this complication (Davis, 1937; Koucky, Beck, and Atlas, 1941; Doran and Doran, 1943; Porritt, Hughes, and Campbell, 1944; Bradmore and Scorer, 1953) give the impression of a very high incidence of perforation, but the overall perforation rate is reckoned to be in the region of 15–20 per cent. Occasionally there is perforation into another segment of bowel forming a fistulous track (Chigot, 1936; Marcuse and Stout, 1950; Bertin and Bovo, 1956). Involvement of regional lymph-nodes is said to be in the region of 50 per cent or more, but Warren and Lulenski (1942) found nodal involvement in only 5 out of 28 specimens examined.

Histology.—Microscopically these lesions can be separated into giant-follicle lymphoma, Hodgkin's disease, small-cell lymphosarcoma, large-cell lymphosarcoma, and reticulosarcoma. If strict criteria were adopted, primary Hodgkin's disease of the gastro-intestinal tract is rare, though in Warren and Lulenski's series it was the commonest type of malignant lymphoma (*Figs.* 365, 366). Most alimentary tract lymphomas belong to the lymphosarcoma–reticulosarcoma group and it is here that nomenclature used by various authors differs so widely as to make comparisons of different series virtually impossible. 'Small-cell lymphosarcoma' is best reserved for lesions in which the cell type is essentially of the size and structure of the normal lymphocyte (*see Fig.* 364). 'Large-cell lymphosarcoma' refers to those in which lymphoblast-like cells dominate the picture with varying numbers of intermediate forms between these and mature lymphocytes. Another difficulty in classification lies in the inherent tendency to cytological variation in the primary tumour or its metastases. There is no doubt that the jejunal tumour in *Case* 15 would be variably classified as lymphosarcoma or reticulosarcoma by different observers. Reticulosarcoma must be distinguished from undifferentiated carcinoma; the latter almost always reveals a hint of tubular or acinar structure or mucin secretion, or at least of trabeculæ in which the longer cell diameter is often perpendicular to the supporting stroma. In malignant lymphoma the destruction of muscle in an invaded area is usually more complete. The lack of induction of a fibrous reaction by these tumours is a fundamental feature of their pathology. Where fibrosis is seen it is the result of incidental ulceration and inflammation rather than an inherent characteristic of the tumour. Another interesting feature is the rather sharply circumscribed microscopical appearance in most cases so that the muscle coat of the bowel appears neatly punched out and replaced by the neoplastic mass (*see Fig.* 362). In children the lesion is more likely to be lymphosarcoma than reticulosarcoma. As to the site of origin in the bowel wall, this can only be determined with any certainty in the few specimens in which involvement is more or less restricted to one layer of the gut, and study of these shows that most lymphomas arise in the submucosa (e.g., *Case* 9); a few, however, do arise in the mucosal lamina propria (Marcuse and Stout, 1950; Snoddy, 1952), and according to Maggi (1956) very rarely in the subserous connective tissue.

Prognosis.—This is difficult to assess. Winkelstein and Levy (1943) concluded that lymphosarcoma of the intestines is invariably fatal. Others do not share this view. Histological type is not considered of prognostic importance by most authors, except in so far as giant-follicle lymphoma usually carries a better prognosis (Marcuse and Stout; Skrimshire; our *Case* 13). In children the outlook is said to be poor (Simpson-Smith, 1938). On general grounds, regional node involvement might be expected to be associated with a poorer prognosis and there is a trend in this direction in our material; however, Marshall and Meissner (1950) found no evidence to support this in their series. The site

of the lesion appears to be of greater prognostic significance. Duodenal tumours can rarely be removed and therefore carry a poor prognosis. With gastric lymphoma the outlook is more favourable than with carcinoma (Marshall and Meissner; Madding and Walters, 1940; Thorbjarnarson, Beal, and Pearce, 1956, 1959). Taylor (1939) insisted that every attempt should be made to treat these lesions, no matter how advanced, and that histological diagnosis is essential before pronouncing a gastric neoplasm beyond surgical aid. In Marshall and Meissner's series 12 out of 28 patients submitted to partial gastrectomy were alive for more than 5 years. Usher and Dixon (1943) found the prognosis to be remarkably good in patients with cæcal tumours, more than half of whom were alive and well 5 years after surgery and irradiation; they state that cæcal lesions are more favourable than those in the rectum and much more favourable than those in the small intestine. In lymphosarcoma of the small intestine, Faulkner and Dockerty (1952) found only 4 patients who survived 4 years among 29 who survived operation. However, in the series of Allen, Donaldson, Sniffen, and Goodale (1954) those with tumours of the large bowel fared worse than patients with lesions of the small intestine. Further series are needed to study the importance of separate factors, e.g., histological type and tumour site, in assessing prognosis.

Perhaps the most important factor in prognosis is whether the disease is truly localized or is merely the first clinical manifestation of a generalized disorder (e.g., *Case* 15). Wright (1956) states that the prognosis in malignant lymphoma in any site in the body depends more on whether the disease is localized, and therefore eradicable by surgery, than on its histological type. There are in the literature sufficient cases with long-term follow-ups to show that a fair proportion of malignant lymphomata of the alimentary tract are actually curable. Since clinically and pathologically there is nothing to indicate which lesions are going to remain localized, all patients should be treated with equal enthusiasm. Some do surprisingly well even after apparently inadequate therapy (Taylor, 1939; Stout, 1953). An analysis of apparent cures in lymphosarcoma according to the part of the body first involved (Shimkin, Oppermann, Low-Beer, and Mettier, 1954) is of great interest. In their series there were 10 patients free of disease for between 5 and over 20 years. Of these, as many as 8 had lesions involving primarily organs other than lymph-nodes, and 4 had gastro-intestinal lymphoma. Considering that there were only 18 examples of gastro-intestinal disease and as many as 95 patients presenting with peripheral lymphadenopathy, the significance of these figures can be appreciated. Several reasons could account for this difference. It may be that gastro-intestinal involvement produces symptoms earlier so that treatment is more effective. This is hardly a likely explanation in view of the fact that cæcal tumours are reputed to carry a relatively good prognosis. It is possible that localization in the alimentary tract improves the prognosis by facilitating surgical eradication. This may well play a part, but is by no means the whole story. The remaining alternatives are that malignant lymphoma of the bowel is often a localized disease process, or else that some cases, at any rate, of what we at present call malignant lymphoma of the gastro-intestinal tract are, in fact, examples of a peculiar granulomatous tumour-like condition which mimics closely a genuine neoplasm. The latter concept is analogous to that put forward by Brewer and Orr (1953) in relation to the thyroid. While support for this idea may derive from a few series in which gastro-intestinal lymphomata tend to separate into two groups—a majority with rapidly fatal outcome and a significant minority of long survivors—it is equally well explained by postulating rapid recurrence in many incompletely eradicated tumours and by the small size of any one series. The pathology of the lesion in our longest survivor certainly indicates a malignant neoplasia and we are forced to the conclusion that the relatively better prognosis of gastro-intestinal lymphoma is associated with its being more often a localized disease than the corresponding tumours which first present clinically as peripheral or central lymphadenopathy.

Treatment.—This consists of surgical resection whenever feasible, with removal of as many of the regional lymph-nodes as possible. Post-operative deep X-ray therapy is not essential, but desirable. Snoddy (1952) recommends it for cases with lymph-node involvement or where pathological examination shows that the tumour has been incompletely removed. References to patients cured by radiotherapy alone are given by Marcuse and Stout (1950) and Snoddy. Inoperable tumours should be treated by radiotherapy. Biopsy of all malignant gastro-intestinal lesions at laparotomy is essential; biopsy of enlarged lymph-nodes is unsatisfactory as it frequently shows only follicular hyperplasia, and the nature of the neoplasm may be missed. While all authors are agreed that lymphosarcoma of the bowel is radio-sensitive, occasional reports (e.g., Yarnis and Colp, 1943) suggest that reticulosarcoma is usually resistant. McSwain and Beal (1944), however, found that reticulum-cell sarcoma was also radio-sensitive.

SUMMARY

1. Clinicopathological data on 20 patients with primary malignant lymphoma of the gastro-intestinal tract are presented. The difficulties of clinical, radiological, and operative diagnosis are discussed. There is a high incidence of perforation into the peritoneal cavity. Younger age-groups are affected more frequently than with carcinoma.

2. Lesions are frequently infiltrative in type and may diffusely affect the stomach wall. Ulcerated lesions are frequent in the stomach. Annular infiltrating tumours are common in the bowel, but are less often tightly constricting than in the case of carcinoma. There is a notable paucity of fibrous reaction, which accounts for the frequency of perforation. Multiple tumours are not common.

3. There is lack of uniformity in histological classification among different authors. Most lesions fall into the lymphosarcoma–reticulosarcoma group. A case of Hodgkin's disease of the stomach is here reported. The only positive relationship between microscopical type and prognosis is the apparently better prognosis associated with giant-follicular lymphoma. Regional lymph-node involvement is found in approximately half the cases.

4. The prognosis is considered in relation to age, microscopical type, lymph-node involvement, and the viscus involved. Patients with gastric and cæcal lesions appear to fare better than those with tumours of the small intestine. The prognosis with gastric lymphoma is better than with carcinoma. The prognosis with large, apparently inoperable tumours is, on occasion, surprisingly favourable. Six out of 9 potential 5-year survivors are alive and well between 5¾ and 15¼ years after operation.

5. The possible reasons for the relatively good prognosis are discussed, and it is concluded that this is related to the fact that malignant lymphoma of the alimentary tract is more often localized than the corresponding diseases presenting clinically with peripheral or central lymphadenopathy.

6. Treatment consists of surgical extirpation of the lesion together with its lymphatic drainage whenever possible, with post-operative radiotherapy in selected cases. Inoperable tumours should be treated by radiotherapy.

7. The more recent literature on the subject is reviewed.

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REFERENCES

ALLEN, A. W., DONALDSON, G., SNIFFEN, R. C., and GOODALE, F., jun. (1954), *Ann. Surg.*, **140**, 428.
BERTIN, G., and BOVO, G. (1956), *Arch. Sci. med.*, **102**, 28.
BRADMORE, H. M., and SCORER, C. G. (1953), *Brit. J. Surg.*, **41**, 152.
BRESNIHAN, P. C., and JONES, K. (1953), *J. Irish med. Ass.*, **32**, 106.
BREWER, D. B., and ORR, J. W. (1953), *J. Path. Bact.*, **65**, 193.
BURMAN, S. O., and VAN WYK, F. A. K. (1956), *Ann. Surg.*, **143**, 349.
CHIGOT, P. L. (1936), *Ann. anat. path.*, **13**, 515.
CHONT, L. K. (1941), *Radiology*, **36**, 86.
DAVIS, E. (1937), *Brit. med. J.*, **2**, 64.
DORAN, W. T., and DORAN, W. T., jun. (1943), *Amer. J. Surg.*, **61**, 136.
ELLIOTT, G. V., and WILSON, H. M. (1952), *Arch. intern. Med.*, **89**, 358.
FAULKNER, J. W., and DOCKERTY, M. B. (1952), *Surg. Gynec. Obstet.*, **95**, 76.
FRANK, L. W., MILLER, A. J., and BELL, J. C. (1942), *Ann. Surg.*, **115**, 544.
FRASER, K. (1945), *Brit. J. Surg.*, **32**, 479.
INGELFINGER, F. J. (1957), *New Engl. J. Med.*, **256**, 357.
IRVINE, W. T., and JOHNSTONE, J. M. (1955), *Brit. J. Surg.*, **42**, 611.
KOUCKY, J. D., BECK, W. C., and ATLAS, J. (1941), *Ann. Surg.*, **114**, 1112.
LAME, E. L., VELAT, C. A., and CUSTER, R. P. (1954), *Ann. intern. Med.*, **40**, 57.
MCSWAIN, B., and BEAL, J. M. (1944), *Ann. Surg.*, **119**, 108.
MADDING, G. F., and WALTERS, W. (1940), *Arch. Surg., Chicago*, **40**, 120.
MAGGI, L. (1956), *Arch. De Vecchi*, **25**, 427.
MARCUSE, P. M., and STOUT, A. P. (1950), *Cancer*, **3**, 459.
MARSHALL, S. F., and MEISSNER, W. A. (1950), *Ann. Surg.*, **131**, 824.
O'BEIRN, S. (1955), *J. Irish med. Ass.*, **36**, 172.
PORRITT, A. E., HUGHES, K. E. A., and CAMPBELL, R. J. C. (1944), *Brit. J. Surg.*, **31**, 395.
SHIMKIN, M. B., OPPERMANN, K. C., LOW-BEER, B. V. A., and METTIER, S. R. (1954), *Ann. intern. Med.*, **40**, 1095.
SIMPSON-SMITH, A. (1938), *Brit. J. Surg.*, **26**, 429.
SKRIMSHIRE, J. F. P. (1955), *Quart. J. Med.*, **24**, 203.
SNODDY, W. T. (1952), *Gastroenterology*, **20**, 537.
STOUT, A. P. (1953), "Tumours of the Stomach". *Atlas of Tumor Pathology*, Sect. VI, Fasc. 21, p. 85. Washington: Armed Forces Institute of Pathology.
TAYLOR, E. S. (1939), *Ann. Surg.*, **110**, 200.
THORBJARNARSON, B., BEAL, J. M., and PEARCE, J. M. (1956), *Cancer*, **9**, 712.
— — PEARCE, J. M., and BEAL, J. M. (1959), *Amer. J. Surg.*, **97**, 36.
ULLMAN, A., and ABESHOUSE, B. S. (1932), *Ann. Surg.*, **95**, 878.
USHER, F. C., and DIXON, C. F. (1943), *Gastroenterology*, **1**, 160.
WARREN, S., and LULENSKI, C. R. (1942), *Ann. Surg.*, **115**, 1.
WINKELSTEIN, A., and LEVY, M. H. (1943), *Gastroenterology*, **1**, 1093.
WRIGHT, C. J. E. (1956), *Amer. J. Path.*, **32**, 201.
YARNIS, H., and COLP, R. (1943), *Gastroenterology*, **1**, 1022.

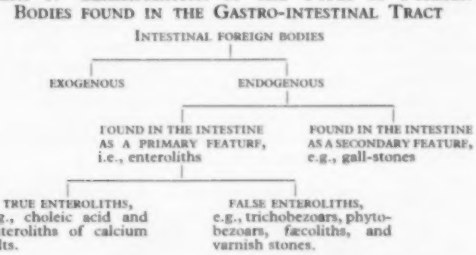
INTESTINAL CALCULI

By J. D. ATWELL and A. V. POLLOCK,* Leeds

Foreign bodies in the intestine may be of endogenous or exogenous origin. Endogenous foreign bodies may be formed primarily in the intestine (enteroliths), or they may enter the intestine from adjacent sources (e.g., gall-stones).

Endogenous foreign bodies or enteroliths were further subdivided by Grettve (1947) into true and false enteroliths. False enteroliths are formed by the clumping together of large amounts of insoluble ingested material or by simple inspissation of intestinal contents. These are the phytobezoars, trichobezoars, and fæcoliths. True enteroliths are formed as a result of percipitation and deposition of substances present in the normal alimentary chyme: the most characteristic are calculi containing choleic acid, and those containing calcium salts. A classification of foreign bodies in the intestine is shown in *Table I.*

Table I.—Classification of the Types of Foreign Bodies found in the Gastro-intestinal Tract


INTESTINAL FOREIGN BODIES
EXOGENOUS
ENDOGENOUS
FOUND IN THE INTESTINE AS A PRIMARY FEATURE, i.e., enteroliths
FOUND IN THE INTESTINE AS A SECONDARY FEATURE, e.g., gall-stones
TRUE ENTEROLITHS, e.g., choleic acid and enteroliths of calcium salts.
FALSE ENTEROLITHS, e.g., trichobezoars, phytobezoars, fæcoliths, and varnish stones.

During the past ten years 9 patients with true enteroliths have been seen at the General Infirmary at Leeds. It is the purpose of this paper to present 8 of these patients and to discuss some of the factors responsible for the enteroliths. The ninth case has previously been reported by Armitage, Fowweather, and Johnstone (1950).

CASE REPORTS

The patients have been divided into two groups: Group I contains 4 examples of choleic acid enteroliths; Group II consists of 4 cases of enteroliths, the principal constituent of which is calcium. The chemical analysis of the calculi in Group II has been published by Fowweather (1955).

Group I: Choleic Acid Enteroliths.—

Case 1.—A woman aged 65 years was admitted on June 10, 1956, with colicky central abdominal pain, vomiting, and absolute constipation of three days' duration. Appendicectomy had been performed forty years previously. She had suffered from angina of effort for three months.

She was found to be moderately dehydrated. The pulse-rate was 108 per minute. The abdomen was distended and hyperactive bowel-sounds were present. A plain radiograph of the abdomen revealed several dilated coils of small intestine with fluid levels.

Laparotomy was performed on the day of admission and the clinical diagnosis of small-bowel obstruction was confirmed. The site of obstruction was about 5 ft. distal to the duodenojejunal flexure. The obstruction was due to impaction of an enterolith, which was removed by enterotomy. Three feet proximal to the site of impaction two large empty diverticula were seen adjacent to the mesenteric border of the jejunum. The gall-bladder was normal. The patient's post-operative course was uneventful.

The enterolith was analysed by Professor Fowweather with the following result: choleic acid 83·72 per cent, free fatty acids 6·96 per cent, neutral fats 2·62 per cent, food residues 6·15 per cent, ash 0·55 per cent.

Case 2.—A woman aged 68 years was admitted on Dec. 11, 1957, with colicky central abdominal pain, vomiting, and absolute constipation of three days' duration. She had previously had no abdominal complaints,

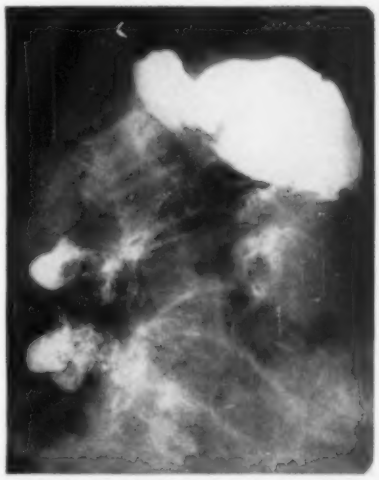


Fig. 367.—*Case* 2. Radiograph after barium meal, showing two diverticula of the second part of the duodenum, the probable site of origin of a choleic acid enterolith.

but she suffered from recurrent attacks of winter bronchitis.

Examination showed a dehydrated and ill-looking elderly female with a pulse-rate of 96 per minute. The abdomen was distended and tenderness was present in the right iliac fossa.

At laparotomy on the day of admission the site of obstruction was found to be 8 in. proximal to the ileocæcal valve, where an impacted enterolith was felt. The stone was removed by enterotomy. The gall-bladder was normal and no jejunal or ileal diverticula were seen. The duodenum was not examined.

After operation she developed paralytic ileus. This was successfully treated by intravenous fluids and gastric suction. A barium-meal radiographic examination on the tenth day demonstrated a sliding œsophageal hiatus hernia with gastro-œsophageal reflux and two diverticula of the second part of the duodenum (*Fig.* 367). Cholecystography was normal.

Signs of peritonitis developed on the fourteenth day and the abdomen was re-opened. The enterotomy wound was found to have disrupted and was repaired by a

* Now at Scarborough Hospital.

side-to-side anastomosis with an adjacent adherent loop of ileum. The patient died five days later.

Necropsy showed suppurative peritonitis and bronchopneumonia. The gall-bladder and ducts were normal. Two diverticula were demonstrated in the duodenum (*Fig.* 368).

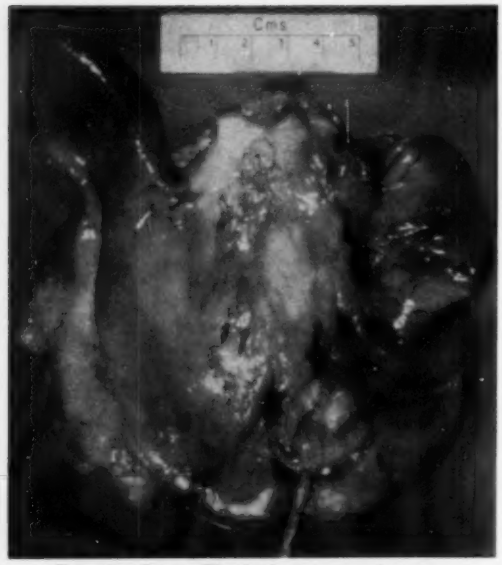


FIG. 368.—*Case* 2. The duodenum removed at necropsy showing two diverticula, the probable site of origin of a choleic acid enterolith.

The enterolith was analysed by Dr. A. Howarth, who reported the following composition: choleic acid 52 per cent, free fatty acids 12·5 per cent, neutral fats 9·6 per cent, water 7·7 per cent, insoluble residue 18·2 per cent. The insoluble residue was a fruit stone.

FIG. 369.—*Case* 4. Radiograph after barium meal showing a sliding œsophageal hiatus hernia with gastro-œsophageal reflux and a large solitary duodenal diverticulum with a filling defect due to an enterolith.

Case 3.—A woman aged 63 years was admitted on Sept. 26, 1958, with severe central abdominal pain, fæculent vomiting, and absolute constipation of two days' duration. The patient had previously suffered from endogenous depression but had had no abdominal complaints.

Examination showed a dehydrated elderly woman. The pulse-rate was 126 per minute. The central abdomen was distended and tender and there was a palpable mass in the umbilical region. A plain radiograph of the abdomen showed several distended loops of small intestine and fluid levels. The urine contained 1–2 per cent of sugar and the blood-sugar was 210 mg. per 100 ml.

Laparotomy was performed on the day of admission and showed an enterolith impacted about 4 ft. distal to the duodenojejunal junction. The wall of the intestine for about 2 ft. proximal to the impaction was dilated, injected, œdematous, and covered by fibrinous exudate. The gut was considered viable and the enterolith was removed by enterotomy. The abdomen was closed after leading a rubber drain to the site of enterotomy. The gall-bladder was normal.

Post-operatively this patient developed a fæcal fistula on the fifth day. The abdomen was re-explored on the tenth day and 3 in. of gangrenous intestine was excised proximal to the original enterotomy wound. An end-to-end anastomosis was made. The patient recovered slowly from this operation. Her diabetes was difficult to control and following a transient attack of hypoglycæmia the patient developed a state of 'akinetic mutism'. This was probably the result of cerebral damage caused by hypoglycæmia in association with chronic anoxia and senile vascular changes. She was finally discharged on Nov. 15, 1958.

A barium-meal examination later demonstrated a duodenal diverticulum.

FIG. 370.—*Case* 4. Shows the gall-bladder and multiple cholesterol stones removed at operation, a fruit skin, and granular material comprising a choleic acid enterolith removed from the duodenal diverticulum.

The enterolith was analysed by Dr. Howarth with the following result: choleic acid 73·9 per cent, free fatty acids 3·1 per cent, neutral fats 0·4 per cent, water 5·2 per cent, insoluble residue containing the remains of a fruit skin 17·3 per cent.

Case 4.—A woman aged 66 years was referred to an out-patient clinic. She gave a history of epigastric discomfort for three years. The pain did not radiate and was unrelated to meals. She occasionally regurgitated 'thick saliva' and this was associated with retrosternal discomfort. She was moderately obese and abdominal examination showed no tenderness, rigidity, or abnormal masses. Combined cholecystography and barium-meal examination revealed a sliding œsophageal hiatus hernia with gastro-œsophageal reflux, multiple non-opaque gall-stones, and a large solitary duodenal diverticulum with a filling defect (*Fig.* 369).

The patient was admitted to hospital and on Oct. 8, 1958, the abdomen was explored through a right paramedian incision. The gall-bladder was normal in size and was free from adhesions. The gall-bladder wall was thickened and the organ contained numerous gall-stones.

The duodenum was mobilized and a large peri-Vaterian diverticulum was found. On opening this diverticulum a large soft enterolith was found, consisting of a fruit skin surrounded by a mass of yellow granular material. After removal of the enterolith a nipple with a single orifice was found at the apex of the diverticulum. This proved to be the common orifice of the pancreatic and common bile-ducts. Sphincterotomy of the sphincter of Oddi was followed by excision of part of the wall of the diverticulum and removal of the gall-bladder.

Immediately after this operation the patient developed acute hæmorrhagic pancreatitis with a serum-amylase of 4000 units per 100 ml. The serum-calcium fell to 6·0 mg. per 100 ml. She appeared to be recovering from the pancreatitis, but on the thirteenth post-operative day dehiscence of the abdominal wound occurred and required resuture. Bronchopneumonia developed and the patient died on the next day.

At necropsy areas of recent fat necrosis were seen in the omentum and retroperitoneal tissues. The whole pancreas was involved by necrosis, which was hæmorrhagic towards the body and the tail. Both lungs showed signs of bronchopneumonia.

Dr. A. Howarth analysed the enterolith and reported as follows: choleic acid 67·1 per cent, free fatty acids 6·9 per cent, neutral fats 2·1 per cent, water 4·0 per cent, insoluble residue containing the remnants of a fruit skin 19·2 per cent.

Fig. 370 shows the gall-bladder, the cholesterol gall-stones, a fruit skin forming the basis of the enterolith, and part of the enterolith itself.

Group II: Calcium Enteroliths.—

Case 5.—A woman aged 65 years was seen in a surgical out-patient clinic, complaining of recurrent attacks of colicky central abdominal pain associated with vomiting and abdominal distension. The attacks had occurred three to four times a year over the preceding twenty years. The patient now had attacks of pain at weekly intervals. She had lost 4 st. in weight in ten years.

Examination showed an undernourished middle-aged woman. There was some general abdominal distension, but no masses were palpated. Rectal examination negative.

Plain radiographs of the abdomen demonstrated seven opacities shaped like plum stones (*Fig.* 371). The opacities had a calcified outer layer. A barium meal was followed through and demonstrated that the opacities were in the small intestine.

Laparotomy was performed on Dec. 5, 1950. The peritoneal cavity contained free serous fluid. Large hypertrophied and distended coils of ileum were seen and two stones were palpated in the ileum proximal to a hypertrophic lesion in the lower ileum which appeared to be typical of Crohn's disease. The mesenteric lymph-nodes were enlarged. Distally multiple further strictures were found over a distance of about 12 in., the most distal lesion being 3 in. from the ileocæcal valve. Seven enteroliths and two plum stones were removed through six enterotomies. A nodule in the intestinal wall was excised and sent for histological examination. An ileo-transverse colostomy completed the operation.

The excised nodule was shown histologically to be an argentaffin carcinoma invading the muscularis of the bowel.

FIG. 371.—*Case* 5. Multiple calcium-containing enteroliths in the intestine demonstrated by a plain radiograph. The opacities have a well-defined calcified outer layer.

The patient made a good immediate recovery. She was seen six months later with severe hypoproteinæmia œdema (total serum-proteins 3·6 g. per 100 ml.). Her condition temporarily improved on a high-protein diet, but she later died in another hospital. Necropsy was not performed.

The chemical analysis of these enteroliths has been described in detail by Fowweather (1955). He found: choleic acid 5·45 per cent, free fatty acids 0·27 per cent, neutral fats 0·15 per cent, water 5·16 per cent, calcium oxalate 85·11 per cent, calcium sulphate 0·78 per cent, insoluble residue including plum stone 3·08 per cent.

Case 6.—A woman aged 63 years was admitted on July 9, 1952, after passing bright red blood per rectum for 24 hours. Her general health was good and she had lost no weight. She had had a similar episode of rectal bleeding ten years previously. Entero-anastomosis had been performed fifty years previously for intestinal obstruction of uncertain nature.

She appeared to be in good condition. The pulse-rate was 80 per minute. Abdominal examination was negative apart from a laparotomy scar. Rectal examination revealed altered blood on the finger. Proctoscopy and sigmoidoscopy to 25 cm. showed no abnormality. Investigation of the blood showed a hæmoglobin level of 95 per cent (14 g. per 100 ml.). A barium meal was followed through and demonstrated an ileal diverticulum which contained four opacities. The stomach and duodenum were normal with no radiographic evidence of intestinal obstruction.

Laparotomy was performed three weeks after admission. Numerous adhesions were divided and a short-loop entero-anastomosis was displayed 12 in. proximal to the ileocæcal valve. The excluded loop contained four enteroliths and was resected. The open ends of the ileum were closed. The patient made an uneventful recovery.

The enteroliths were analysed (Fowweather, 1955) and the following composition was found: choleic acid 11·48 per cent, free fatty acids 0·15 per cent, neutral fats 0·44 per cent, calcium oxalate 83·45 per cent, insoluble residue 4·48 per cent.

Case 7.—A woman aged 47 years was admitted on June 28, 1953, with central and lower abdominal pain of ten days' duration. Vomiting occurred on the day prior to admission. Her temperature was 100° F. Abdominal examination revealed a tender and fixed mass in the right iliac fossa and a diagnosis of appendix abscess was made.

The patient was treated conservatively and there was clinical improvement, the patient being discharged after 11 days. Similar symptoms recurred two weeks later and led to further investigations being made. A barium-enema examination revealed a smooth indentation of the cæcum and a laminated shadow was apparent in this region.

Finally, on Sept. 11, 1953, right hemicolectomy was done and the patient made a good recovery. The specimen showed a laminated stone impacted in the ileocæcal valve.

Professor F. S. Fowweather (1955) analysed the enterolith and reported its composition: choleic acid 3·78 per cent, neutral fats 2·47 per cent, insoluble residue 24·30 per cent, calcium oxalate 23·0 per cent, calcium phosphate 44·25 per cent, undetermined 2·20 per cent.

Case 8.—A man aged 39 years was admitted on Jan. 30, 1956, with abdominal pain around the umbilicus of five years' duration. The pain settled in the right iliac fossa. Vomiting occurred on three occasions. Unaltered blood had been passed rectally on the day of admission. He was found to have a temperature of 98° F. The pulse-rate was 90 per minute. There was tenderness in the right iliac fossa on abdominal examination.

FIG. 372.—*Case* 8. A plain radiograph of the abdomen showing a group of three opacities in the right iliac fossa. At operation an acutely inflamed appendix was removed containing three enteroliths.

A plain radiograph of the abdomen showed a group of three opacities in the right iliac fossa (*Fig.* 372). A diagnosis of acute appendicitis was made and the appendix was removed through a gridiron incision. The appendix was acutely inflamed and contained three enteroliths. The patient's recovery was uneventful.

Professor F. S. Fowweather (1955) reported that analysis of the enteroliths showed: calcium phosphate 61·9 per cent, calcium carbonate 26·7 per cent, calcium oxalate 1·2 per cent, calcium sulphate 1·5 per cent, insoluble residue 8·7 per cent.

DISCUSSION

Enteroliths are rare. In 1935 Blix recorded an enterolith containing 58 per cent calcium oxalate and 11 per cent choleic acid and reviewed the 8 previously recorded cases of choleic acid enteroliths in the literature. At that time only one case had been reported in the British literature (Raper, 1921).

Aetiology.—This series has been divided into two groups, Group I consisting of enteroliths formed high in the small intestine and containing a high proportion of choleic acid, and Group II being formed at a lower level and containing a large amount of calcium. As will be discussed later, the site of enterolith formation is related to the chemical composition of the stone.

Age.—The average age of patients in Group I is 65 years, with a range from 63 to 68 years. Slater (1953), Goodall (1948), Crassweller (1952), Ogilvie (1940), Terry and Mugler (1921), Phillips (case 2) (1921), Armitage, Fowweather, and Johnstone (1950), Ward McQuaid and Gordon (1950), and Grettve (1947) described cases of enterolith formation in duodenal or jejunal diverticula, the average age of the 9 patients being 65 years with a range from 46 to 85 years.

The patients in Group II have an average age of 50 years, ranging from 39 to 65 years. Eleven patients described by Palmstrom (1950), Harland (1953), Walker (1945), Richards (1951), Bunch and Adcock (1939), Kelly (1932), Chapple (1950), Basile and Elfersy (1951), and Appell and Klotz (1952) range in age from 32 to 74 years, the average being 48 years.

This difference in the average age of the two groups reflects a difference in their aetiology, particularly concerning the mechanical condition giving rise to enterolith formation. The causative lesions in the lower small intestine may be strictures due to healed tuberculous lesions or Crohn's disease, both of which occur in younger people. Meckel's diverticulum and the appendix, both sites of enterolith formation, are present from birth and therefore complications are expected at an earlier age than those which may arise in acquired lesions such as duodenal and jejunal diverticula.

Metabolic disturbances may also be involved in the age difference and this is discussed later.

Sex.—No authentic choleic acid enterolith occurring in a male is described in the literature. Ward McQuaid and Gordon (1950) described an enterolith found at necropsy in a man aged 80 years which lay within a duodenal diverticulum. No accurate chemical analysis of this stone is available, but the authors stated that it consisted mainly of fatty and bile acids with only traces of bilirubin and cholesterol. They named it a 'choleic acid enterolith'. The stone was radio-opaque, which argues against its being a true

choleic acid stone. True choleic acid enteroliths in the present series all occurred in females. It seems likely that a metabolic process peculiar to females plays a part in causing choleic acid enteroliths.

In Group II there are 3 females and 1 male. Of the 11 patients described in the literature 4 were females and 7 males. It seems likely that the sex of the patient is unimportant in the aetiology of stones formed in the lower half of the small intestine.

Table II.—A Series of Previously Reported Cases of Enteroliths showing the Type of Mechanical Defect producing Stasis, e.g., Diverticula and Strictures, and the Type of Nucleus found which facilitates Precipitation of the Substances concerned to form an Enterolith

Author	Site of Origin of the Enterolith	Type of 'Nucleus'
Phillips (1921)		
Case 1	Duodenal diverticulum	Plume stone
Case 2	Duodenal diverticulum	Fruit skin
Hellström (1929)		
Case 1	Multiple strictures of ileum (Tuberculous)	No obvious nucleus
Case 2	Probable duodenal diverticulum	No obvious nucleus
Case 3	Probable duodenal diverticulum (Tuberculous)	Nucleus of vegetable pulp
Case 4	Multiple strictures of ileum (Tuberculous)	Nucleus of vegetable pulp
Case 5	Single stricture of ileum	No obvious nucleus
Case 6	Jejunal diverticulum	No obvious nucleus
Goodall (1948)	Duodenal and jejunal diverticula	Fæcal core
Chapple (1950)	Appendix	Soft central core of vegetable pulp
Ward McQuaid and Gordon (1950)	Duodenal diverticulum	Small organic nucleus
Armitage, Fowweather, and Johnstone (1950)	Duodenal and jejunal diverticula	Fruit stone

Mechanico-physical Factors.—In the small intestine stasis does not occur except under special conditions. These were enumerated by Grettve (1947) under the title 'mechanico-physical factors'.

Stone formation depends primarily upon precipitation of substances in solution or colloidal suspension and the accumulation of the precipitated material. Certain mechanical derangements in the small intestine allow the accumulation of precipitated substances, leading to enterolith formation.

The commonest site of origin of enteroliths is in a diverticulum of the duodenum or jejunum and *Cases* 1–4 of this series all had diverticula. The association of enteroliths with diverticula has also been reported by Phillips (1921), Hellström (1929), Ogilvie (1940), Shaw (1940), Goodall (1948), Armitage, Fowweather, and Johnstone (1950), McQuaid and Gordon (1950), Crassweller (1952), and Slater (1953).

In the lower small intestine acquired diverticula are unusual but congenital diverticula are common, Meckel's diverticulum being found in 2 per cent of the population. The formation of an enterolith in a Meckel's diverticulum has been described by Palmstrom (1950), Basile and Elfersy (1951), and Appell and Klotz (1952). The last case was unusual in that the central portion of the diverticulum was constricted and the enteroliths were formed only in the distal portion. This implies that the size of the aperture to a diverticulum is important, the smaller the opening the greater being the stasis.

The absence of a muscular wall in acquired diverticula also favours stasis; in congenital diverticula, on the other hand, contraction of the normal muscle coat will tend to empty the contents of the diverticulum.

Long-standing strictures of the ileum occur as a result of ileocæcal tuberculosis, Crohn's disease, or argentaffin carcinoma, or as a result of previous strangulation or intestinal surgery. *Case* 5 demonstrates multiple strictures associated with multiple enteroliths. Kelly (1932) described an example of enterolith formation between two strictures of the ileum, the result of healed tuberculosis. Richards (1951) and Blix (1935) also reported similar instances of the association of strictures and enteroliths.

Short-circuiting operations lead to the production of a 'blind loop'. This occurred in *Case* 6 where entero-anastomosis had been performed 50 years previously for intestinal obstruction. On removal of the loop at laparotomy it was found to contain multiple enteroliths.

The appendix is considered to be a congenital diverticulum and the high incidence of fæcoliths within its lumen is attributed to its small lumen compared with that of Meckel's diverticulum. True enterolith formation in an appendix is rare; Bunch and Adcock (1939) reported a giant calculus of the appendix, and *Case* 8 of this series is another example. Chapple (1950) described 2 similar cases.

Enteroliths in the appendix are usually a mixture of the true and the false types. A fæcolith is produced initially, leading to partial obstruction and stasis. This favours the deposition of calcium salts around the central core.

Harland (1953) described enteroliths in the colon of a male aged 42 years with idiopathic megacolon. The enteroliths were found only between the cæcum and a stricture at the site of a previous left iliac colostomy.

The size of the mouth of a diverticulum is important, large-mouthed sacs being less liable to stasis than narrow-mouthed diverticula. This explains the high incidence of fæcoliths in diverticula in the

large intestine and the rarity of enteroliths in the small intestine.

Another factor causing stasis within the diverticulum is the presence of foreign bodies such as insoluble ingested matter, e.g., fruit stones and fruit skins. This is seen in *Case* 4, in which an enterolith was being formed on the basis of a fruit skin, and in *Case* 5, in which the majority of the enteroliths were produced around a nucleus consisting of fruit stones or similar material. Appendicular calculi demonstrate the deposition of calcium salts around a fæcal core.

The presence of a foreign body within a diverticulum irritates the mucous membrane and favours bacterial infection, both of which may play some part in enterolith formation. Grettve (1947) stated that enteroliths are "more often without any definite nucleus". This is not supported by the cases described in the literature and the findings in the present series. *Tables II* and *III* show the site of origin and the type of nucleus in 12 enteroliths from the literature and the 8 patients in the present series.

Chemical Factors.—The mechanical factors favouring precipitation of enteroliths have been considered.

Table III.—Demonstrates the Site of Enterolith Formation in the Present Series and the Type of 'Nucleus' found facilitating Enterolith Formation

Case No.	Site of Origin of Enterolith	Type of 'Nucleus'
Case 1	Jejunal diverticulum	Fruit skin
Case 2	Duodenal diverticulum	Fruit stone
Case 3	Duodenal diverticulum	Fruit skin
Case 4	Duodenal diverticulum	Fruit skin
Case 5	Multiple strictures of ileum	Fruit stones
Case 6	Blind loop of ileum	Fruit stone
Case 7	Unknown	24 per cent organic matter
Case 8	Appendix	Fæcolith

Certain chemical factors must now be examined—namely, the hydrogen-ion concentration of the intestinal contents, the solubility coefficients of precipitated substances, the source of precipitated material, and the presence of a nucleus.

It is unusual to find water-soluble substances as components of enteroliths.

Choleic acid enteroliths: This substance is absent or present only in minute amounts in human bile. Human gall-bladder bile contains bile acids in the conjugated and unconjugated form. Doubilet (1936) states that the percentage of conjugated acids in the form of glycocholic and taurocholic acids is 8·86, whereas unconjugated cholic acid and deoxycholic acid account for 4·25 per cent and 5·5 per cent respectively. In conditions of derangement of cholesterol metabolism an increased excretion of unconjugated cholic and deoxycholic acids may occur.

Raper (1921) stated that the glycocholic acid fraction is responsible for the production of choleic acid, suggesting that it is precipitated as such and then converted by bacterial action into choleic acid. It is now recognized, however, that choleic acid is probably formed from deoxycholic acid (Karrer, 1950; Rodd, 1953).

The production of choleic acid may be increased under certain conditions when there is an increased output of bile acids in the free and conjugated forms. The state of our knowledge of such changes is at present inadequate. There is, however, evidence suggesting that the production of choleic acid enteroliths may be the result of a metabolic upset because these stones occur only in females. *Table IV* lists all the proved choleic acid stones in the literature, including the present series, and bears out this observation. In *Table V* the chemical composition of the choleic acid enteroliths in the present series is given in greater detail.

Table IV.—The Percentage Concentration of Choleic Acid in Previously Reported Enteroliths and including the Choleic Acid Enteroliths of the Present Series. (*Cases* 1–4)

Author	Age	Sex	Choleic Acid Concentration
			per cent
Phillips (1921)			Unknown
Case 1	65	F.	
Case 2	68	F.	72
Hellström (1929)			
Case 1	34	F.	60·0
Case 2	63	F.	76·0
Case 3	50	F.	89·6
Case 4	39	F.	56·4
Case 5	31	F.	85·8
Case 6	75	F.	84·0
Blix (1935)	51	F.	79·0
Armitage, Fowweather, and Johnstone (1950)	73	F.	93·7
Present series			
Case 1	65	F.	83·7
Case 2	68	F.	52·0
Case 3	63	F.	73·9
Case 4	66	F.	67·1

Calcium-containing enteroliths: Calcium is present in the normal fæces. The amount present in the small intestine depends largely upon dietary intake and absorption.

Calcium oxalate, phosphate, carbonate, and sulphate are present in these enteroliths. These compounds are more soluble in alkaline than in acid media, and hence have a greater tendency to form in the lower parts of the small intestine. *Table VI* summarizes the chemical analysis of the calcium stones in this series.

Hydrogen-ion concentration of intestinal contents: The *p*H of the intestinal contents is important in the precipitation of sodium salts of the bile acids. This was demonstrated by Fowweather (1949), who showed that choleic acid precipitated most readily at a *p*H of 7·0, cholic acid at *p*H 5·8–6·0, and glycocholic acid at *p*H 4·6–4·8.

The *p*H of the jejunal contents is 6·5, according to McGee and Hastings (1942). These authors demonstrated that an efficient buffering system exists to maintain this *p*H. It can be assumed that the hydrogen-ion concentration in any part of the small intestine is confined within narrow limits.

The *p*H in the upper intestinal tract is lower than in the lower small intestine. Bockus (1946) gives the

*p*H of intestinal secretion as 8·0 to 9·0. This is reflected in the composition of enteroliths formed at different levels of the intestinal tract. In the present series, this is shown in *Table VII*.

Nucleus or central core: As stated when mechanical factors were discussed, a nucleus or central core favours stasis within a diverticulum, thus allowing precipitation to occur more readily. Another possible factor is that precipitation from a supersaturated or unstable solution is facilitated by the presence of a foreign body (cf. the growth of alum crystals on a thread of cotton).

Table V.—Chemical Composition of the Choleic Acid Enteroliths in the Present Series. (*Cases* 1–4)

Case No.	Choleic Acid	Free Fatty Acids	Neutral Fats	Water	Insoluble Residue
Case 1	per cent 83·7	per cent 6·9	per cent 2·6	per cent —	per cent 6·7
Case 2	52·0	12·5	9·6	7·7	18·2
Case 3	73·9	3·1	0·4	5·2	17·3
Case 4	67·1	6·9	2·1	4·0	19·2

Table VI.—Chemical Composition of the Calcium-containing Enteroliths in the Present Series. (*Cases* 5–8)

Case No.	Calcium Oxalate	Calcium Phosphate	Calcium Sulphate	Calcium Carbonate
Case 5	per cent 85·1	per cent —	per cent 0·7	per cent —
Case 6	83·4	—	—	—
Case 7	23·0	44·2	—	—
Case 8	1·2	61·9	1·5	26·7

Table VII.—Demonstrates that the Site of Formation of Enteroliths is reflected in Their Chemical Composition. The Concentration of Choleic Acid decreases as the Concentration of Calcium Compounds increases on passing from the Upper to the Lower Small Intestine

Case No.	Site of Enterolith Formation	Percentage Choleic Acid	Percentage Calcium
Case 1	Jejunal diverticulum	per cent 83·7	per cent Nil
Case 2	Duodenal diverticulum	52·0	Nil
Case 3	Duodenal diverticulum	73·9	Nil
Case 4	Duodenal diverticulum	67·1	Nil
Case 5	Ileum (multiple strictures)	5·4	85·8
Case 6	Ileum (blind loop)	11·4	83·4
Case 7	Unknown	3·7	67·2
Case 8	Appendix	Nil	91·3

Relation to Gall-stones.—In *Cases* 1–3 the normality of the biliary apparatus was confirmed by operation, radiological examination, or at necropsy. In *Case* 4 cholesterol stones were present in the gall-bladder, but the common bile-duct was of normal size and free from calculi. It may well be that enteroliths causing intestinal obstruction have sometimes been mistaken for gall-stones, and until chemical analysis is performed upon material removed at operation, further elucidation of the problem of enteroliths is unlikely.

Clinical Features.—Enteroliths are usually symptomless while they remain within a diverticulum. Clinical signs result from complications, usually from extrusion of the stone into the intestine.

Enteroliths commonly cause acute intestinal obstruction: this occurred in 5 cases in the present series. Impaction of an enterolith in the intestine may lead to perforation and peritonitis; this was reported by Phillips (1921) and Blix (1935), and occurred in *Case* 3 of this series. Hæmorrhage was a feature of the history in *Cases* 6 and 8.

It is rare for an enterolith to cause diverticulitis. Milnes Walker (1945) described an acquired diverticulum in the lower ileum inflamed and distended with pus and containing a concretion in a woman aged 51 years. Chapple (1950) described 2 cases of true appendicular enteroliths presenting with acute obstructive appendicitis and appendix abscess respectively. This condition was simulated in *Cases* 7 and 8 of the present series.

Ogilvie (1940) described a case of acute hæmorrhagic pancreatitis in a woman aged 46 years. At necropsy a duodenal diverticulum containing an enterolith was found in relation to the pancreatic and common bile-ducts. Pressure on the ducts may have led to this complication. Acute hæmorrhagic pancreatitis developed in *Case* 4 of this series following removal of an enterolith from a duodenal diverticulum and partial removal of the diverticulum.

Pathological Features.—Radiology can demonstrate enteroliths formed in the lower small intestine as these contain calcium salts (*Figs.* 371, 372).

Enteroliths formed in the upper small intestine contain very little calcium and are radio-translucent. Plain radiography of the abdomen is, however, useful in the diagnosis of intestinal obstruction. *Fig.* 373 demonstrates fluid levels and distended loops of small intestine in *Case* 3 with enterolith obstruction.

Barium-meal examination may demonstrate the presence of duodenal diverticula (*Fig.* 367) and *Case* 4 the filling defect caused by an enterolith in a diverticulum (*Fig.* 369).

Treatment.—If an enterolith is detected within an intestinal diverticulum it should be removed, together with the whole or the major part of the

diverticulum. There is a considerable risk of such a stone being extruded into the intestine, there to cause obstruction. There is also a theoretical risk of hæmorrhage from or perforation of the diverticulum.

The great majority of choleic acid enteroliths of Group I are discovered during the course of a

FIG. 373.—*Case* 3. Plain radiograph of the abdomen demonstrating fluid levels and distended loops of small intestine due to enterolith obstruction.

laparotomy for acute intestinal obstruction. When the surgeon has assured himself that the stone does not originate in the gall-bladder, there are two possible lines of treatment open to him. There is of course a great temptation to open the bowel and remove the stone. It is our opinion that this is not the best form of treatment, as there is a considerable risk of breakdown of the enterotomy wound with resulting peritonitis (*see Cases* 2 and 3).

Choleic acid enteroliths are usually quite soft and friable and can be fractured by pressure through the intact bowel wall. The fragments will then be passed on and the obstruction relieved. A search should be made for a diverticulum in which the enterolith may have originated, but it is probably wise to avoid resection of the diverticulum at the time of acute obstruction.

The calcium enteroliths of Group II require a different approach, as they are nearly always associated with a congenital or acquired ileal diverticulum (including the appendix) or with an intestinal stricture. The underlying cause usually requires resection or a short-circuiting operation at the same time as the enterolith is removed: in fact these enteroliths may be purely incidental to the more important underlying abnormality.

SUMMARY

1. Eight patients are presented who had true enteroliths removed and analysed.

2. True enteroliths may be divided on the basis of chemical composition and site of formation into choleic acid enteroliths formed in upper intestinal diverticula, and calcium enteroliths formed in the lower small intestine.

3. Some of the physical and chemical conditions which lead to enterolith formation are discussed.

4. It is recommended that choleic acid enteroliths should be crushed through the intact bowel wall, whereas calcium enteroliths should be removed together with their causative lesion.

Addendum.—Since this paper was written an additional patient with a calcium enterolith has come under the care of one of us (A. V. P.). He is a man aged 80 years whose 'appendix abscess' partially resolved under conservative treatment. A hard mass remained palpable, an enterolith was seen radiographically in the right iliac fossa, and the appendix was removed. It had perforated at the tip and extruded an enterolith weighing 0·68 g. which consisted of calcium phosphate, bile-pigments, and cholesterol on an organic core. The patient made a good recovery.

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REFERENCES

APPELL, A. A., and KLOTZ, P. G. (1952), *Canad. med. Ass. J.*, **66**, 476.
ARMITAGE, G., FOWWEATHER, F. S., and JOHNSTONE, A. S. (1950), *Brit. J. Surg.*, **38**, 21.
BASILE, A. R., and ELFERSY, M. (1951), *Gastroenterology*, **18**, 287.
BLIX, G. (1935), *Acta chir. scand.*, **76**, 25.
BOCKUS, H. L. (1946), *Gastroenterology*. Philadelphia: W. B. Saunders.
BUNCH, G. H., and ADCOCK, D. F. (1939), *Ann. Surg.*, **109**, 143.
CHAPPLE, C. F. (1950), *Brit. J. Surg.*, **38**, 503.
CRASSWELLER, H. (1952), *Canad. med. Ass. J.*, **67**, 149.
DOUBILET, H. (1936), *Proc. Soc. exp. Biol., N.Y.*, **34**, 86.
FOWWEATHER, F. S. (1949), *Biochem. J.*, **44**, 607.
— — (1955), *Brit. med. J.*, **2**, 1010.
GOODALL, A. L. (1948), *Ibid.*, **2**, 206.
GRETTVE, S. (1947), *Acta chir. scand.*, **95**, 387.
HARLAND, D. (1953), *Brit. J. Surg.*, **41**, 14.
HELLSTRÖM, J. (1929), *Acta chir. scand.*, **64**, 79.
KARRER, P. (1950), *Organic Chemistry*. New York: Elsevier Publishing Co. Inc.
KELLY, R. E. (1932), *Brit. J. Surg.*, **20**, 168.
MCGEE, L. C., and HASTINGS, A. B. (1942), *J. biol. Chem.*, **142**, 893.
MCQUAID, J. N. WARD, and GORDON, E. G. (1950), *Brit. J. Surg.*, **38**, 109.
OGILVIE, R. (1940), *Ibid.*, **28**, 362.
PALMSTROM, A. (1950), *Acta chir. scand.*, **99**, 163.
PHILLIPS, J. (1921), *Brit. J. Surg.*, **8**, 378.
RAPER, H. S. (1921), *Biochem. J.*, **15**, 49.
RICHARDS, H. J. (1951), *Brit. med. J.*, **2**, 1384.
RODD, E. H. (1953), *Chemistry of Carbon Compounds*. Amsterdam: Elsevier Publishing Co.
SHAW, J. J. M. (1940), *Brit. J. Surg.*, **28**, 328.
SLATER, N. S. (1953), *Ibid.*, **41**, 60.
TERRY, W. I., and MUGLER, F. R. (1921), *Arch. Surg. Chicago*, **2**, 347.
WALKER, R. M. (1945), *Brit. J. Surg.*, **32**, 457.

THE PATHOGENESIS OF SEGMENTAL ENTERITIS

By P. C. MEYER

FROM THE CENTRAL HISTOLOGICAL LABORATORY, WHITTINGTON HOSPITAL, LONDON

A GROSS and disproportionate hypertrophy of the muscularis mucosæ is a most uncommon finding in intestinal lesions, and although its occurrence in segmental enteritis has already been mentioned by some authors (Owens, 1944; van Patter, Bargen, Dockerty, Feldman, Mayo, and Waugh, 1954) this finding is not widely appreciated, while its significance remains obscure.

An attempt has been made, therefore, to investigate the frequency of this change in segmental enteritis and to determine, if possible, its specificity for this condition. At the same time the opportunity has been taken to review the histological material in the files of this department and to assess the relevant findings with regard to various hypotheses which have been advanced to explain the aetiology of this disease.

CASE MATERIAL

The files of this department contain material from 42 examples of segmental enteritis occurring between the years 1938 and 1958 inclusive, of which 36 were surgical in origin while the remaining 6 were taken at necropsy. This series includes one example of acute typhlitis having a total clinical history of 22 hours' duration, but no case of acute ileitis as defined by Pollock (1958) could be found.

METHOD OF STUDY

The thickness of the muscularis mucosæ was determined microscopically with the aid of a micrometer eye-piece and measurements were made at intervals of at least 0·5 cm. along each strip of bowel, care being taken to avoid tangential cuts. The minimum vertical thickness of this muscle coat at each point was recorded and areas where the outline was indistinct were avoided. The thicknesses of the circular and longitudinal muscle coats on the same radii of the bowel were also measured. It was found that accurate measurements could be made on 22 of the examples in the above series, and in each of these cases there was clearly some degree of intestinal obstruction recognized by the presence of hypertrophy in the longitudinal and circular muscle coats.

For control purposes examples of intestinal obstruction due to other causes, as well as normal bowels and examples of congenital anomalies, were treated in exactly the same manner. In the selection of the control material identity of sex and approximate site of the lesion were obtained while the ages of the respective cases were made to correspond as closely as possible.

In the further examination of the examples of segmental enteritis the presence or absence of 'sarcoid' granulomata in the bowels and lymph-glands was determined. Search was also made for the presence of reticulo-endothelial hyperplasia in the lymphatics of the bowel and sinuses of the regional lymph-glands. Lymphatic œdema was assessed as accurately as possible and the presence or absence of histiocytic infiltration was noted. The state of the myenteric plexuses was studied, and finally, the occurrence of a gastric type of mucosa in the bowel, when present, was recorded.

RESULTS

The recorded measurements are shown in *Table I*. The first column includes the 22 examples of segmental enteritis. The second column includes examples of intestinal obstruction showing muscular hypertrophy of the bowel, as well as the small group of congenital anomalies studied. The third column includes measurements made on bowels showing no evidence of muscular hypertrophy although congestion and œdema were present in some of these cases. The sex and age of each case are quoted, while the site of the lesion is recorded in the first column and the nature of the pathological condition in the second column. The cases quoted in the second column were selected to cover the field of pathology as widely as possible. Control material corresponding to *Case* 12 could not be found. In some cases it was only possible to obtain one measurement on a particular strip of bowel, although in many cases five or six measurements were made. The results are shown as vulgar fractions. In each case the numerator (T1) represents the sum of the thicknesses of the circular and longitudinal muscle coats, while the denominator (T2) represents the thickness of the muscularis mucosæ on the same radius of the bowel, all figures being given to the nearest 10 μ. To facilitate comparison, the two fractions having the largest and smallest numerical ratios obtained from measurements on a single strip of bowel are shown together in each column, where possible.

It can be seen that a large proportion of cases of segmental enteritis show a disproportionate focal hypertrophy of the muscularis mucosæ (*Fig.* 374), while in intestinal obstruction due to other causes and in the examples of congenital anomalies there is little or no hypertrophy of this muscular layer. In the present series some of the cases of segmental enteritis, i.e., *Cases* 5, 11, and 14, do not show this differential muscular hypertrophy, and it is emphasized that the change in involved segments of bowel is definitely focal in character, both in the longitudinal and transverse axes. The increased thickness is clearly the result of hypertrophy associated with an irregular hyperplasia of muscle bundles and some new formation of collagen. In some cases the change is of such degree that the thickness of the muscularis mucosæ equals or even exceeds that of the other two muscle coats combined. When present, therefore, the finding of this differential muscular hypertrophy may be taken as specific for segmental enteritis.

Granulomata of 'sarcoid' type (*Fig.* 375) were found in the bowel in 8 cases, while one case (*Case* 9) showed a sparse infiltration of lymphatics by epitheloid cells and Langhans giant cells (*Fig.* 376), apparently the precursor of the granulomatous reaction. In 6 cases there was a 'sarcoid' type of

Table I.—Measurements of Thicknesses of Muscle Coats in 22 Cases of Segmental Enteritis and Corresponding Control Material

Segmental Enteritis			Hypertrophied Bowels and Congenital Anomalies (Control Material)		Normal Bowels (Control Material)	
Case No.	Age, Sex, Site of Lesion	$\frac{T1}{T2}$ (in μ)	Age, Sex, Pathology	$\frac{T1}{T2}$ (in μ)	Age, Sex	$\frac{T1}{T2}$ (in μ)
1	21, M. Terminal ileum	$\frac{1540}{670}$ $\frac{1450}{900}$	21, M. Meckel's diverticulum	$\frac{1120}{20}$ $\frac{1240}{30}$	18, M.	$\frac{290}{10}$ $\frac{290}{10}$
2	56, F. Terminal ileum	$\frac{2000}{710}$ $\frac{1520}{1330}$	60, F. Secondary carcinoma	$\frac{1430}{20}$ $\frac{1090}{20}$	59, F.	$\frac{570}{30}$ $\frac{200}{20}$
3	22, F. Terminal ileum	$\frac{2570}{950}$ $\frac{2570}{1190}$	34, F. Endometriosis	$\frac{1570}{10}$ $\frac{2140}{20}$	29, F.	$\frac{520}{20}$
4	—, M. Ileum	$\frac{1570}{140}$ $\frac{1190}{190}$	—, M. Secondary sarcoma	$\frac{1240}{50}$ $\frac{900}{50}$	—, M.	$\frac{200}{10}$ $\frac{100}{10}$
5	21, F. Terminal ileum	$\frac{690}{10}$	32, F. Meckel's diverticulum	$\frac{1070}{10}$ $\frac{810}{20}$	20, F.	$\frac{290}{10}$ $\frac{310}{20}$
6	22, M. Terminal ileum	$\frac{2000}{570}$ $\frac{2190}{1050}$	28, M. Diverticulum	$\frac{1330}{20}$ $\frac{1050}{50}$	19, M.	$\frac{140}{20}$ $\frac{130}{20}$
7	37, F. Ileum	$\frac{2040}{20}$ $\frac{1280}{570}$	37, F. Endometriosis	$\frac{1660}{10}$ $\frac{1050}{40}$	35, F.	$\frac{570}{10}$ $\frac{420}{20}$
8	31, M. Colon	$\frac{1520}{620}$ $\frac{1590}{810}$	47, M. Carcinoma of cæcum	$\frac{1760}{20}$ $\frac{1470}{30}$	37, M.	$\frac{900}{20}$ $\frac{400}{30}$
9	28, F. Ileum	$\frac{3610}{860}$ $\frac{2420}{1520}$	28, F. Old tuberculosis	$\frac{2230}{40}$ $\frac{1520}{50}$	30, F.	$\frac{140}{10}$ $\frac{110}{20}$
10	22, M. Ileum	$\frac{1660}{100}$ $\frac{1190}{1190}$	35, M. Diverticulum	$\frac{950}{20}$ $\frac{900}{20}$	22, M.	$\frac{430}{20}$ $\frac{480}{30}$
11	68, F. Ileum	$\frac{1430}{20}$ $\frac{1160}{40}$	77, F. Carcinoma of cæcum	$\frac{1470}{10}$ $\frac{2760}{50}$	69, F.	$\frac{360}{20}$
12	12, F. Colon	$\frac{1520}{20}$ $\frac{1330}{670}$	—	—	—	—
13	53, F. Ileum	$\frac{1280}{520}$ $\frac{1240}{1330}$	51, F. Hodgkin's disease	$\frac{2040}{20}$ $\frac{1850}{20}$	51, F.	$\frac{250}{10}$ $\frac{160}{10}$
14	65, F. Colon	$\frac{3210}{30}$ $\frac{2660}{30}$	63, F. Primary carcinoma	$\frac{2330}{50}$ $\frac{2190}{50}$	57, F.	$\frac{290}{10}$
15	25, F. Ileum	$\frac{1710}{100}$ $\frac{2040}{1900}$	38, F. Chronic abscess	$\frac{1900}{30}$ $\frac{1020}{30}$	24, F.	$\frac{310}{20}$
16	43, M. Ileum	$\frac{1000}{100}$ $\frac{2000}{1050}$	51, M. Lymphosarcoma	$\frac{1470}{20}$ $\frac{900}{30}$	48, M.	$\frac{440}{20}$ $\frac{290}{20}$
17	63, M. Colon	$\frac{2570}{810}$ $\frac{1570}{570}$	55, M. Primary carcinoma	$\frac{2190}{40}$	68, M.	$\frac{520}{20}$ $\frac{300}{30}$
18	69, M. Ileum	$\frac{1810}{10}$ $\frac{1950}{1760}$	77, M. Leiomyosarcoma	$\frac{830}{20}$ $\frac{1280}{50}$	78, M.	$\frac{460}{10}$ $\frac{380}{20}$
19	23, M. Ileum	$\frac{1540}{70}$ $\frac{2280}{1520}$	38, M. Old tuberculosis	$\frac{1880}{10}$ $\frac{1730}{20}$	30, M.	$\frac{350}{20}$ $\frac{330}{20}$
20	31, M. Ileum	$\frac{2090}{860}$ $\frac{2280}{1000}$	39, M. Intussusception	$\frac{1240}{10}$ $\frac{1190}{30}$	51, M.	$\frac{290}{10}$ $\frac{520}{20}$
21	26, F. Ileum	$\frac{1900}{1280}$	29, F. Tuberculosis	$\frac{2760}{50}$	28, F.	$\frac{550}{10}$ $\frac{410}{30}$
22	40, F. Ileum	$\frac{1880}{20}$ $\frac{2610}{70}$	34, F. Ileostomy (ulcerative colitis)	$\frac{3560}{50}$	46, F.	$\frac{560}{20}$ $\frac{520}{40}$

reaction in the regional lymph-glands and in 3 of these 6 there were no corresponding changes in the strip of bowel examined. Foreign-body giant cells containing monorefringent material were found in 4 cases, but Schaumann bodies and asteroids could not be identified. The 'sarcoid' granulomata were usually most numerous in the submucosa of the bowel and their precise location in relation to the lymphatics could not always be determined, but in

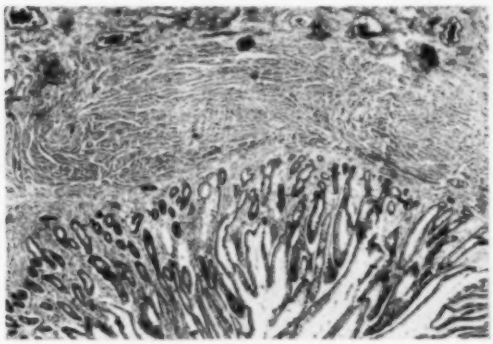

FIG. 374.—The greatly hypertrophied muscularis mucosæ is composed of interlacing bundles of smooth muscle-fibres and situated between the mucosa and vascular submucosa. (× 18.)

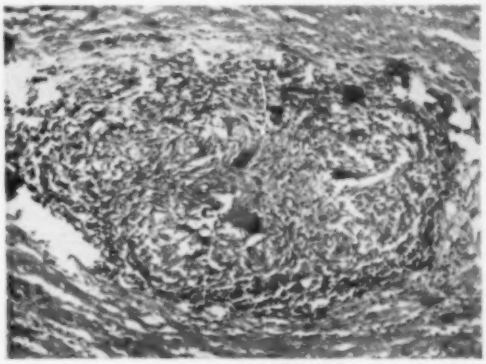

FIG. 375.—The granuloma of 'sarcoid' type is located in the muscular coat of the bowel. (× 82.)

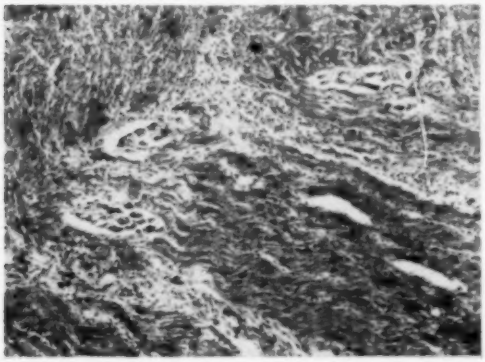

FIG. 376.—The lymphatics in the muscular coat of the bowel show a sparse infiltration by epitheloid cells and Langhans giant cells, apparently the precursor of the granulomatous reaction. (× 57.)

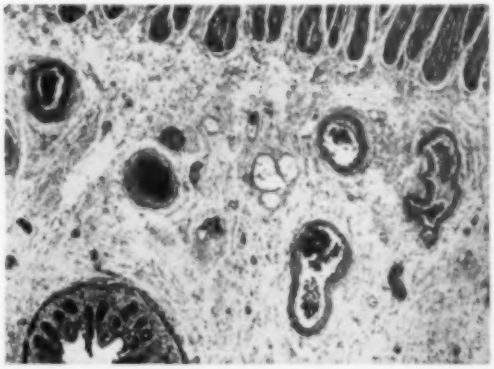

FIG. 377.—The submucosa shows great œdema and dilatation of lymphatics. There is an absence of cellular reaction in the lumina of the dilated lymphatics and the submucosa shows a virtual absence of inflammatory infiltration. (× 26.)

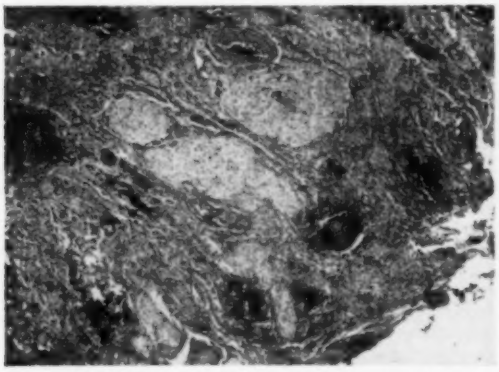

FIG. 378.—The pale-staining nerve-bundles are conspicuous in the submucosa, the site of severe purulent inflammation with ulceration. (× 22.)

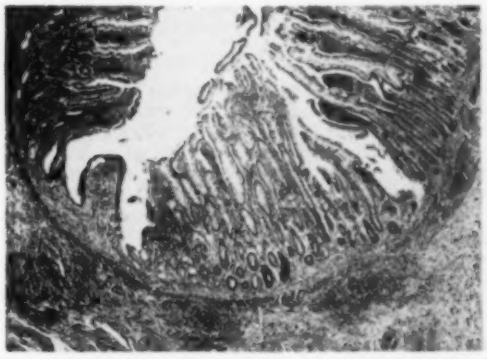

FIG. 379.—The small intestine can be identified by the presence of a few villi, but the branching mucus-secreting ducts and small acini produce a structure resembling that of pyloric mucosa. (× 18.)

one case (*Case* 9), already referred to, the reaction appeared to be starting in the lumina (*Fig.* 376), while in others an early development outside the lymphatics was observed.

Reticuloendothelial hyperplasia was observed in lymphatics in the bowel and mesentery and found to vary greatly in degree and distribution. It was found to parallel roughly the degree of purulent inflammation in each case, and where this change was poorly developed or absent there was little or no reticuloendothelial hyperplasia in the lymphatics (*Fig.* 377).

Lymphatic œdema of some degree was present in all of the cases and in some the change was very marked. Occasionally, as in *Case* 11, it was associated with a singular absence of inflammatory change (*Fig.* 377) and it was always most marked in the submucosa. Lymphatic œdema was also present in the other coats of the bowel and mesentery although it was much less prominent in the longitudinal muscle coat.

A diffuse and focal lymphoid infiltration, the latter originating in the lymph-follicles, was a conspicuous feature in most of the cases. All coats of the bowel were affected by this change, but especially the submucosa, and in most cases it formed part of a more pleomorphic inflammatory infiltration.

Histiocytic infiltration was frequently observed in the mucosa and submucosa, but always in association with purulent inflammation and abscess formation. In no case did the appearance in any way resemble that described in Whipple's disease.

In most cases Auerbach's plexus was very prominent, showing œdema and apparently hyperplasia of nerve-bundles, while the ganglion cells were large and appeared to show a numerical increase. It must be emphasized that these particular findings were no more than a strong impression, since only routine material stained by hæmatoxylin and eosin and by van Gieson's method for collagen was studied. In 2 cases a neuromatous proliferation of nerve-bundles was observed in the submucosa (*Fig.* 378), but this change was closely related to the presence of focal purulent inflammation.

Finally, the presence in focal areas of a type of pyloric mucosa was observed in the small intestine in 8 examples of segmental enteritis; in a few it was a conspicuous feature (*Fig.* 379).

DISCUSSION

The occurrence of conspicuous submucous lymphatic œdema in segmental enteritis has been noted by many authors, but its significance has been interpreted in different ways. Thus, in studies of large series of cases Warren and Sommers (1948, 1954) considered that the lymphœdema results from obstructive lymphangitis and perilymphangitis proceeding to granuloma formation, while in an earlier study Blackburn, Hadfield, and Hunt (1939) regarded lymphadenoid hyperplasia as the primary aetiological factor. Rappaport, Burgoyne, and Smetana (1951) and van Patter and others (1954) favoured the former view, while Laipply (1957) was non-committal. Incidentally, Rappaport and others found intralymphatic granulomas in only 12 per cent of 100 cases and considered that the fundamental pathological process was a productive inflammation. The review of the present series of cases supports the concept of a primary lymphatic œdema, but the occurrence of such cases as the one showing a combined absence of lymphoid hyperplasia, inflammatory changes, and obstructive lymphangitis, as depicted in *Fig.* 379, suggests most strongly that inflammatory endothelial hyperplasia of lymphatics is not the primary factor causing obstruction. In this connexion it must be remembered that a secondary proliferation of endothelial cells tends to obliterate the lumina of small lymphatics, the seat of chronic inflammation (Kaufmann, 1929), and that a similar change is a constant finding in lymph-glands affected by sinus catarrh (Marshall, 1956).

The precise level of the lymphatic obstruction is debatable and is most probably located in the bowel, although a primary involvement of the mesenteric lymph-glands has been suggested (Erskine, 1941). In the present series of cases there was a notable preponderance of lymphatic œdema in the circular muscle coat compared with that found in the longitudinal muscle coat. This suggests that the lymphatic obstruction is located between the two main muscle coats, also the site of an extensive lymphatic plexus (Maximow and Bloom, 1957). It is most probably of a functional nature, the result of incoordination affecting the two muscle coats; by analogy, the great importance of skeletal muscular action in the transport of lymph is well recognized (Lovatt Evans, 1956). The greatest support for the concept of a severe and prolonged lymphatic œdema is provided by the occurrence of the inconstant but specific and often conspicuous differential hypertrophy of the muscularis mucosæ confirmed in the present study. This is most logically interpreted as being compensatory in nature since it is known that the muscularis mucosæ extends into the cores of the villi and that their contractions are responsible for the emptying of the central lacteals into the submucous lymphatic plexus (Maximow and Bloom). It has further been suggested by Ham (1957) that the muscularis mucosæ may act on occasion to relieve pressure on the veins in the submucosa caused by the tone of the external muscular coats. The association of pronounced submucous lymphœdema with hypertrophy of the muscularis mucosæ becomes, therefore, understandable, and the suggestion of van Patter and others that the changes in the muscularis mucosæ represent a true leiomyomatous proliferation need not be accepted.

Some indirect evidence for the importance of a neuropathic factor in the pathogenesis of this disease has by now accumulated. Thus in a very detailed study Davis, Dockerty, and Mayo (1955) showed that persons suffering from segmental enteritis possess a complement of ganglion cells in the myenteric plexus of the ileum approximately three times that of normal subjects, but argued that the change is probably an acquired one rather than a congenital abnormality. Early involvement of Auerbach's plexus by inflammatory changes has been noted by Barbour and Stokes (1936) and by Schepers (1945), but these findings receive no positive support from the present study, while the suggestion of Schepers, that the disease may be the result of a primary virus

infection affecting the cœliac plexus or mesenteric ganglia, remains pure conjecture.

In 1933 Homans and Hass drew attention to the close resemblance between the histological features of segmental enteritis and those of sarcoidosis, a point stressed again by Hadfield (1939). Both these conditions were classified as specific diseases by Hadfield and Harrison (1953), and Ficarra (1956) has accepted segmental enteritis as a form of reticulosis. During the last two decades, however, this analogy has lost much of its significance. Thus one of the few cases of pulmonary sarcoidosis associated with segmental enteritis remains that reported by Morland (1947), and even the validity of this one has been challenged by Crohn (1949), while Phear (1958) could find no similarity between the two conditions, except for the presence of a positive tuberculin reaction in only 11 out of 35 cases of segmental enteritis. Further, in a necropsy study, Chapin, Scudamore, Baggenstoss, and Bargen (1956) were able to find a non-caseating granuloma in the liver of only one case of segmental enteritis. In this connexion it must be appreciated that the whole concept of sarcoidosis has changed during the same period. Thus, the finding of 'sarcoid' granulomata in the regional lymph-glands of carcinomas, originally described by Wolbach (1911), is now well recognized (Gresham and Ackerley, 1958), while the syndrome of sarcoidosis is now considered to have a multiple aetiology (Michael, 1958).

Although segmental enteritis cannot be accepted as an intestinal form of sarcoidosis the precise nature of these granulomata is still of great interest. In the present series intestinal 'sarcoid' granulomata were found in 8 out of 42 cases, a much lower proportion than previously reported. Thus Warren and Sommers (1948) found granulomata in 83 per cent of their cases, but these included giant cells in only 43 per cent of cases, while Rappaport and others (1951) found tubercle-like granulomata in almost 50 per cent of their cases. It is clear that 'sarcoid' granulomata are found in a very variable proportion of cases and the separation of a group under the heading "non-caseous tuberculated enterocolitis" by Hoon, Dockerty, and Pemberton (1950) appears quite unjustified. The view of Homans and Hass (1933) that the giant cell reaction represents a response to absorbed lipoid material is still one of the most plausible that have been suggested; it is known that a granulomatous reaction in the tissues can be stimulated by the presence of fat (Paterson, 1938; Hass, 1938), and it is clear that the pronounced degree of lymphangiectasis must predispose to the leakage of lipoid-containing material into the interstitial tissues of the bowel. A connexion between segmental enteritis and Whipple's disease has been suggested by Avery Jones and Paulley (1949), but to this hypothesis there are serious objections on histological grounds. Thus the large aggregates of foamy mononuclear cells in the intestinal and mesenteric lymphatic tissues described by Whipple (1907) were conspicuous by their absence, both in the present series of cases of segmental enteritis and in much larger series reported in the literature; moreover, there is now some evidence of systemic involvement in Whipple's disease (Sieracki and Fine, 1959).

Table II.—THE CLINICAL COURSE OF ACUTE ILEITIS

AUTHOR AND YEAR	TOTAL NO. OF CASES	NO. OF CASES APPARENTLY CURED AND PERIOD OF OBSERVATION						DEFINITE OR POSSIBLE RECURRENCE
		Up to 1 yr.	1–3 yr.	3–5 yr.	5–10 yr.	Over 10 yr.	Precise Period not stated	
Lehman, 1939	7	2	1	1	2	0	0	1
Eliason and Johnson, 1940	15	4	3	0	1	0	0	7
Smithy and Charleston, 1943	5	1	2	0	1	0	0	1
Homb, 1946	33	28	0	0	0	0	0	5
Armitage and Wilson, 1950	10	0	0	0	0	0	10	0
Storrs and Hockelman, 1953	8	1	1	1	1	4	0	0
Austin, 1956	5	0	0	0	5	0	0	0
Crohn and Yarnis, 1958	31	0	0	0	0	0	14 (Follow-up 2–19 yr.)	17
Pollock, 1958	17	0	0	0	13	0	0	4

The relationship of acute ileitis to chronic segmental enteritis is a crucial and highly controversial question. Since the treatment of acute ileitis is usually conservative the descriptions of histological material are correspondingly few in number, but the histological picture is not entirely hypothetical as has been stated by Jeffrey (1949). From the descriptions of Erb and Farmer (1935), Harris (1940), Warren and Sommers (1948), and Talbot (1958), there emerges a definite histological picture of acute ileitis in which acute inflammation and œdema of the bowel are associated with necrosis and early superficial ulceration; identical changes were present in the single case of acute typhlitis included in the present study. The present investigation has shown that lymphatic œdema, unassociated with inflammatory changes, is present in the earliest stages of

chronic segmental enteritis, so that on histological grounds alone the two conditions must be considered as entirely separate entities. At this point the importance of separating unrelated and secondary inflammatory changes must be emphasized. Thus Liber (1951) and Kawel and Tesluk (1955) have described the occurrence of gastric metaplasia in the intestinal mucosa in chronic segmental enteritis, but this change is regarded as purely coincidental by Morson (1959), while the occasional presence of neuromata is most probably the result of severe secondary inflammation. The clinical evidence for the complete separation of the two conditions is very impressive, although not absolutely conclusive. The combined data reported by several authors concerning the clinical course of acute ileitis is presented in *Table II*, in which numbers of cases and durations of freedom from recurrence are correlated. From this it appears that complete recovery is the rule, but it must be remembered that long intervals between recurrences may occur in chronic segmental enteritis; in this connexion intervals of 19½ and 25 years reported by Connelly and Mayo (1955) and Crohn (1958) respectively are of interest. A close relationship between acute ileitis and acute mesenteric lymphadenitis has been suggested by Jackson (1937) although this has been denied by Crohn (1949); at the present time this still remains an open question.

In the field of comparative pathology a detailed study of regional ileitis occurring in pigs has been carried out by Emsbo (1951), who concluded that the porcine and human lesions are fundamentally identical. It is debatable whether the porcine form of regional ileitis and "primary muscular hypertrophy of the porcine ileum" should be classified as distinct entities, as has been suggested by Nielsen (1955), and it would be interesting to know whether the muscularis mucosæ shows the same changes in these two conditions as are found in the human disease. At all events it is clear that these naturally occurring porcine diseases can provide a valuable source of pathological material for further research.

In the experimental field Reichert and Mathes (1936) produced, by the intralymphatic injection of sclerosing substances, a chronic lymphatic œdema affecting the bowels of dogs, and the changes described show a passable resemblance to those occurring in the human subject. Chess, Olander, Puestow, Benner, and Chess (1950) fed dogs with finely divided talc or silica and produced a proliferative cellular response resulting in lymphatic obstruction of the bowel; they concluded that similar changes in the human subject were caused by the action of a physically active sterol. Both these studies, as well as that of Spellberg and Ochsner (1947), in which the effect of non-penetrating trauma to the small intestines of dogs was investigated, appear to throw little light on the pathogenesis of the human disease.

Finally, an association between segmental enteritis and ulcerative colitis appears to have been established by such series of cases as those reported by Jackson (1958), although the importance of a clear distinction between these two conditions has been recently emphasized (*Lancet*, 1958). Such considerations are, however, beyond the scope of this article.

SUMMARY

1. A study of the histological material obtained from 42 examples of segmental enteritis has been carried out with special reference to the occurrence of hypertrophy in the muscularis mucosæ.

2. It has been established by accurate measurement that a large proportion of cases of segmental enteritis show a disproportionate and focal hypertrophy of this muscle layer. By comparison with control material from examples of intestinal obstruction due to other causes, congenital anomalies, and normal bowels, it has been shown further that the change is entirely specific.

3. It has been postulated that this hypertrophy of the muscularis mucosæ is a reactive change due to the presence of lymphatic œdema occurring in the submucosa.

4. The cause of the lymphatic œdema is most probably a dysfunction involving the circular and longitudinal muscle coats of the bowel.

5. It has been shown that the diffuse and focal inflammatory changes occurring in the bowel are most probably secondary in nature, developing some time after the state of lymphatic œdema has become established.

6. It has been argued that the present evidence, both on clinical and pathological grounds, provides little support for the concept of the common identity of segmental enteritis and sarcoidosis.

7. The reasons for the complete separation of the two entities of acute ileitis and segmental enteritis have been stated.

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REFERENCES

ARMITAGE, G., and WILSON, M. (1950), *Brit. J. Surg.*, **38**, 182.

AUSTIN, W. E. (1956), *Canad. med. Ass. J.*, **74**, 289.

BARBOUR, R. F., and STOKES, A. B. (1936), *Lancet*, **1**, 299.

BLACKBURN, G., HADFIELD, G., and HUNT, A. H. (1939), *St. Bart's Hosp. Rep.*, **72**, 181.

CHAPIN, L. E., SCUDAMORE, H. H., BAGGENSTOSS, A. H., and BARGEN, J. A. (1956), *Gastroenterology*, **30**, 404.

CHESS, S., OLANDER, G., PUESTOW, C. B., BENNER, W., and CHESS, D. (1950), *Surg. Gynec. Obstet.*, **91**, 343.

CONNELLY, M. E., and MAYO, C. W. (1955), *Proc. Mayo Clin.*, **30**, 68.

CROHN, B. B. (1949), *Regional Ileitis*. London: Staples Press.

— — (1958), *Gastroenterologia, Basel*, **89**, 352.

— — and YARNIS, H. (1958), *Regional Ileitis*, 2nd ed. New York: Grune and Stratton.

DAVIS, D. R., DOCKERTY, M. B., and MAYO, C. W. (1955), *Surg. Gynec. Obstet.*, **101**, 208.

ELIASON, E. L., and JOHNSON, J. (1940), *Int. Clin.*, **1**, 123.

EMSBO, P. (1951), *Nord. VetMed.*, **3**, 1.

ERB, I. H., and FARMER, A. W. (1935), *Surg. Gynec. Obstet.*, **61**, 6.

ERSKINE, E. B. (1941), *Amer. J. clin. Path.*, **11**, 706.

EVANS, C. LOVATT (1956), *Principles of Human Physiology*, 12th ed. London: J. & A. Churchill.

FICARRA, B. J. (1956), *Amer. J. Gastro-Ent.*, **26**, 590.
GRESHAM, G. A., and ACKERLEY, A. G. (1958), *J. clin. Path.*, **11**, 244.
HADFIELD, G. (1939), *Lancet*, **2**, 773.
— — and HARRISON, C. V. (1953), "Reticulosis and Reticulosarcoma", in *Recent Advances in Pathology*, 6th ed. London: J. & A. Churchill.
HAM, A. W. (1957), *Histology*, 3rd ed. London: Pitman.
HARRIS, F. I. (1940), *Arch. Pediat.*, **57**, 367.
HASS, G. M. (1938), *Arch. Path. (Lab. Med.)*, **26**, 956.
HOMANS, J., and HASS, G. M. (1933), *New Engl. J. Med.*, **209**, 1315.
HOMB, A. (1946), *Acta chir. scand.*, **94**, 343.
HOON, J. R., DOCKERTY, M. B., and PEMBERTON, J. de J. (1950), *Int. Abstr. Surg.*, **91**, 417.
JACKSON, A. S. (1937), *Surg. Gynec. Obstet.*, **65**, 1.
JACKSON, B. B. (1958), *Ann. Surg.*, **148**, 88.
JEFFREY, J. S. (1949), *Edinb. med. J.*, **56**, 461.
JONES, F. AVERY, and PAULLEY, J. W. (1949), *Lancet*, **1**, 214.
KAUFMANN, E. (1929), *Pathology*, Vol. 1. London: H. K. Lewis.
KAWEL, C. A., jun., and TESLUK, H. (1955), *Gastroenterology*, **28**, 810.
LAIPPLY, T. C. (1957), *J. Amer. med. Ass.*, **165**, 2052.
Lancet (1958), **2**, 836. Leading article.
LEHMAN, E. P. (1939), *Rev. Gastroent.*, **6**, 222.
LIBER, A. F. (1951), *Arch. Path. (Lab. Med.)*, **51**, 205.
MARSHALL, A. H. E. (1956), *An Outline of the Cytology and Pathology of the Reticular Tissue*. Edinburgh: Oliver & Boyd.
MAXIMOW, A. A., and BLOOM, W. (1957), *Textbook of Histology*, 7th ed. Philadelphia: W. B. Saunders.
MICHAEL, M., jun. (1958), *Amer. J. med. Sci.*, **235**, 148.
MORLAND, A. (1947), *Tubercle, Lond.*, **28**, 32.
MORSON, B. C. (1959), *Proc. R. Soc. Med.*, **52**, 6.
NIELSEN, S. W. (1955), *J. Amer. vet. med. Ass.*, **127**, 437.
OWENS, F. M., jun. (1944), *Arch. Surg., Chicago*, **48**, 465.
PATERSON, J. L. H. (1938), *J. Path. Bact.*, **46**, 151.
PHEAR, D. N. (1958), *Lancet*, **2**, 1250.
POLLOCK, A. V. (1958), *Brit. J. Surg.*, **46**, 193.
RAPPAPORT, H., BURGOYNE, F. H., and SMETANA, H. F. (1951), *Milit. Surg.*, **109**, 463.
REICHERT, F. L., and MATHES, M. E. (1936), *Ann. Surg.*, **104**, 601.
SCHEPERS, G. W. H. (1945), *Amer. J. dig. Dis.*, **12**, 97.
SIERACKI, J. C., and FINE, G. (1959), *Arch. Path. (Lab. Med.)*, **67**, 81.
SMITHY, H. G., and CHARLESTON, S. C. (1943), *Surgery*, **13**, 122.
SPELLBERG, M. A., and OCHSNER, A. (1947), *Amer. J. med. Sci.*, **213**, 579.
STORRS, R. C., and HOEKELMAN, R. A. (1953), *New Engl. J. Med.*, **248**, 320.
TALBOT, C. H. (1958), *Proc. R. Soc. Med.*, **51**, 1027.
VAN PATTER, W. N., BARGEN, J. A., DOCKERTY, M. B., FELDMAN, W. H., MAYO, C. W., and WAUGH, J. M. (1954), *Gastroenterology*, **26**, 347.
WARREN, S., and SOMMERS, S. C. (1948), *Amer. J. Path.*, **24**, 475.
— — — — (1954), *J. Amer. med. Ass.*, **154**, 189.
WHIPPLE, G. H. (1907), *Johns Hopk. Hosp. Bull.*, **18**, 382.
WOLBACH, S. B. (1911), *J. med. Res.*, **24**, 243.

HERNIATION THROUGH THE TRANSVERSE MESOCOLON FOLLOWING PARTIAL GASTRECTOMY

BY N. V. ADDISON

SENIOR SURGICAL REGISTRAR, GENERAL INFIRMARY AT LEEDS

STOMAL or small-bowel obstruction is a relatively common complication following partial gastrectomy, and the object of this paper is to draw attention to cases caused by herniation through defects in the transverse mesocolon, which may be accidental tears or openings which are deliberately made in carrying out a posterior anastomosis.

There are many reports of obstruction following gastrectomy in the literature, the most recent by Hibner and Richards (1958). In a series of 648 partial gastrectomies they had to operate on 30 patients who developed stomal or small-bowel obstruction, and 5 of these were explored a second time. Of the 35 cases which required exploration, 34 had definite mechanical obstructions which were relieved, the mortality-rate of this group being 23·3 per cent. The onset of obstructive symptoms varied between 2 days and 29 months after operation. Eastmann and Cole (1949) encountered 7 cases of obstruction in 191 gastrectomies, 5 of these occurring at the stoma, but only 1 required operation. The other 2 were efferent limb obstructions due to kinking and torsion, and both were relieved by operation. Other reports on small-bowel obstruction following partial gastrectomy include Mimpriss and St. Birt (1948) 3 cases, Quinn and Gifford (1950) 5 cases, Warren (1954) 3 cases, Stammers (1954) 16 cases, and Morton, Aldrich, and Hill (1955) 5 cases.

During the years 1950–58 inclusive, 641 partial and subtotal gastrectomies were carried out in this hospital in the surgical unit under the care of Professor Digby Chamberlain. The case histories and operation notes in 535 of the total have been reviewed, the majority having attended the out-patient department at yearly intervals since operation, so that a fairly accurate check on these patients has been possible. In 502 of this series a Polya-type partial gastrectomy was carried out by the retrocolic method with a Hofmeister valve, and in the remaining 33 either a Billroth I or an antecolic Polya gastrectomy was performed. As far as can be ascertained, only 7 of the 535 cases developed a small-bowel obstruction, 4 of which required operative treatment. The other 3 patients were readmitted to hospital with clinical symptoms and signs of small-bowel obstruction, but they recovered on conservative treatment. Of the 4 obstructions which were explored, one was due to a volvulus of the ileum caused by a band, and in another there was an obstruction in the terminal ileum, due to a food bolus of undigested coconut fibres; the other 2 cases were found to have an internal hernia of the small-bowel associated with a retrocolic

anastomosis. Shortly before these 2 cases were personally operated upon in September and October, 1958, a similar case was encountered under the care of Mr. M. C. Oldfield. This paper is based on these 3 cases of internal herniation following a retrocolic partial gastrectomy, and the world literature on this topic is reviewed and discussed.

CASE REPORTS

Case 1.—

CLINICAL HISTORY.—A. J., a butcher aged 46 years, was admitted to this hospital on Feb. 12, 1954, under the care of Mr. M. C. Oldfield. He gave a history of 5 years' indigestion and had a chronic gastric ulcer which had not responded to medical treatment. On Feb. 17 a Polya-type partial gastrectomy was carried out by the retrocolic method with a Hofmeister valve. He made

FIG. 380.—Drawing illustrating herniation of small intestine through a defect in the transverse mesocolon following retrocolic partial gastrectomy. The arrow indicates the direction of the prolapse through an opening which is separate from that occupied by the gastrojejunal anastomosis.

a good recovery, but on the tenth post-operative day began to vomit and complained of a feeling of epigastric fullness. He failed to respond to conservative measures, developing epigastric tenderness and guarding, and on March 5 underwent an exploratory laparotomy.

AT OPERATION.—A loop of jejunum was found to have prolapsed through the opening in the transverse mesocolon at the side of the anastomosis. The loop of bowel was gangrenous and approximately 10 in. was resected and a side-to-side anastomosis carried out. The edges of the opening in the mesocolon were sutured to the anastomosis.

He made a good recovery and was discharged home three weeks later.

ON READMISSION.—He was readmitted on March 11, 1958, and gave a history of 18 hours' severe, colicky, lower abdominal pain, associated with profuse vomiting. His bowels had been opened normally the same day. He also complained of recurrent attacks of colicky pain during the previous four years, which had been relieved by vomiting.

On Examination.—He was found to have a distended abdomen with generalized tenderness. Rectal examination was negative.

At Operation.—The abdomen was explored through a right paramedian incision. The whole of the small intestine was distended and was found to have prolapsed through a large hole in the transverse mesocolon, which was separate from the aperture occupied by the gastrojejunal anastomosis. The hernia was easily reduced and the bowel appeared viable, but on further examination a second internal hernia was discovered. A small loop of ileum had passed through a mesenteric defect at the site of the entero-anastomosis carried out at the previous operation. The loop of bowel, which had undergone a torsion of 360°, was easily reduced and was viable. The defects in the transverse mesocolon and the small-bowel mesentery were closed with catgut sutures.

He made a good recovery and was discharged home three weeks later.

ON SECOND READMISSION.—He was perfectly well until Aug. 21, 1958, when he was readmitted for a second time complaining of 12 hours' severe lower abdominal pain which was getting worse. He had vomited copiously, first food and then bile-stained fluid. His bowels had been opened the same morning.

On Examination.—He was found to be a very thin individual, slightly shocked, and in great pain. The abdomen was distended, with generalized rebound tenderness, and no bowel sounds were audible. Rectal examination was negative. In view of his previous history, a diagnosis of internal herniation was made prior to operation.

At Operation (N. V. A.).—The abdomen was explored through a left paramedian incision, and on opening the peritoneal cavity distended loops of small intestine presented in the wound. The transverse colon was discovered in the pelvis, and it was found that the whole of the small intestine had prolapsed through a large gap in the transverse mesocolon, separate from the opening containing the gastrojejunal anastomosis (*Fig.* 380). The hernia was reduced with difficulty and the bowel was found to be viable. The transverse mesocolon was very thin and flimsy and contained no fatty connective tissues between the serous layers, thus making it difficult to close accurately the large defect. He made a good recovery and was discharged home twelve days later.

Case 2.—

CLINICAL HISTORY.—H. F., an engineer aged 55 years, was admitted to hospital on May 31, 1958, and complained of 20 years' indigestion. A radiograph showed a chronic duodenal ulcer with stenosis, and in view of this a Polya-type partial gastrectomy was carried out by the retrocolic method with a Hofmeister valve, the appendix being removed at the same time. He made a good recovery, being discharged home fourteen days later, but when seen at out-patients one month later, complained of fullness after meals, but no vomiting.

ON READMISSION.—He was readmitted as an emergency on Sept. 29 and gave a history of three days' fairly severe upper abdominal pain. The pain was constant and relieved by vomiting, which had been frequent the previous day. His bowels had been opened normally each day.

On Examination.—He was found to be a very thin individual, the abdomen was not distended, and there was tenderness to the right of the umbilicus. Rectal examination was negative. Plain radiographing of the abdomen was negative, and a provisional diagnosis of anastomotic ulceration was made.

He continued to complain of pain and vomited once daily, but otherwise was able to take his food normally. A barium-meal and follow-through examination revealed no evidence of recurrent ulceration or intestinal obstruction, but the opaque material was slow to pass through the ileocæcal valve. As his symptoms and signs persisted he was operated upon on Oct. 6.

At Operation.—The abdomen was explored through a right central paramedian incision. The transverse colon was found to be present in the pelvis, and in view of the previous experience in *Case* 1, it became obvious that the whole of the small bowel had prolapsed through a gap in the transverse mesocolon. This gap was separate from the opening through which the gastrojejunal anastomosis had passed. The terminal ileum was slightly distended, and the middle colic vascular pedicle was partially obstructing the terminal inch of the ileum. The hernia was easily reduced and the defect in the mesocolon was closed with catgut sutures, although this was not easy in view of the extremely thin mesocolon. The abdomen was closed in layers. The patient made a good recovery and was discharged home perfectly well ten days later.

Case 3.—

CLINICAL HISTORY.—A. R., a salesman aged 62 years, was admitted as an emergency on Oct. 15, 1958. He complained of 6 hours' severe colicky abdominal pain, associated with profuse vomiting. His bowels had been opened the same day. Ten years before, a partial gastrectomy had been carried out by Professor Chamberlain for a chronic duodenal ulcer, the anastomosis being of the retrocolic type. He also said that he had suffered from periodic attacks of epigastric fullness, relieved by a small vomit, ever since his previous operation, but had been very well in between the attacks.

ON EXAMINATION.—He was found to be an extremely thin individual, slightly shocked, and in severe pain. The abdomen was moderately distended, with generalized rebound tenderness; rectal examination was negative.

In view of the recent experience with 2 cases of internal herniation, a correct pre-operative diagnosis was made on this occasion.

AT OPERATION.—The abdomen was explored through a central right paramedian incision. The peritoneal cavity contained clear, free fluid. The small bowel was slightly distended, particularly in the distal ileum. Once again the transverse colon was found to lie in the pelvis, and the whole of the small intestine had prolapsed through the aperture in the mesocolon, but on this occasion at the side of the gastrojejunostomy. The hernia was easily reduced and the bowel was viable. The edge of the aperture in the mesocolon was carefully sutured to the anastomosis.

The patient made a good recovery and was discharged home ten days later.

DISCUSSION

Stammers (1954) analysed 16 cases of small-bowel obstruction following partial gastrectomy, and described six different varieties, five of which were associated with an antecolic anastomosis. The common factor in 15 of the total was the obstruction of a loop of small bowel, which slipped through the hiatus formed by the anastomosis in front and the transverse colon behind. Only 1 of the 16 occurred following a retrocolic gastrectomy, and therefore he concluded that this variety was exceedingly rare. In no case does he describe a herniation through the mesocolon. Case (1958) believes that any type of herniation following gastrectomy is exceedingly rare, but this statement is open to criticism in view of the large number of reported cases.

A review of the world literature during the last thirty years revealed that about 90 individual papers have been published concerning small-bowel obstruction as a sequel to both gastro-enterostomy and partial gastrectomy. No less than 12 of these papers, embracing 15 cases, describe definite obstructions due to internal herniation of the efferent loop following a retrocolic gastrectomy. Thus it would appear that this type of obstruction is not quite so rare as Professor Stammers has suggested. Morton and others (1955) encountered 5 cases of internal herniation, 3 of which complicated the retrocolic anastomosis. In reviewing the literature at that time (mainly in English) they found that approximately 70 cases had been reported, 55 of which complicated a retrocolic gastro-enteric anastomosis. In considering these figures, it will be appreciated that a large proportion of these cases followed a posterior gastro-enterostomy without resection (McAllister, 1948).

Obstruction due to internal herniation is relatively uncommon, the incidence varying from 0·01 to 5 per cent in all cases of acute obstruction in various series (Mock and Mock, 1958).

Hansmann and Morton (1939) reviewed 467 cases of intra-abdominal hernia and found that most of these occurred in or about the paraduodenal fossæ or into the transverse mesocolon.

A typical example of the latter type is reported by Smith (1945), where the small intestine prolapsed through a circular hole in the mesocolon, about 1 in. from the hepatic flexure. It would appear that mesenteric defects are usually developmental in origin, occasionally the result of inflammation, but are most commonly produced by surgery. In reporting 39 cases of internal hernia, Mayo, Stalker, and Miller (1941) found that 20 were secondary to the performance of some surgical procedure, and 10 of these followed a gastro-enterostomy. In 6 cases the jejunum had prolapsed through the opening in the transverse mesocolon at the side of the anastomosis. This type of hernia may occur following a retrocolic gastrectomy, as it did in *Case* 3 reported here, and is, of course, avoided by suturing the edges of the mesocolic opening to the anastomosis. That this condition may exist and be virtually symptom-free is illustrated by an interesting case described by Harries (1938). He carried out a posterior, no-loop gastro-enterostomy for duodenal ulcer, but omitted to close the mesocolic opening. On the fourteenth post-operative day, when the abdominal wound was resutured following dehiscence, it was accidentally discovered that the whole of the small intestine had prolapsed through the transverse mesocolon into the lesser sac. The patient had suffered no obstructive symptoms, but had been troubled for several days with hiccups. The hernia was easily reduced, the gap was closed, and the patient made a good recovery.

In the other 4 cases reported by Mayo and others (1941), a loop of small bowel had become obstructed by passing behind the afferent limb of the anastomosis. In 2 cases the anastomosis was antecolic and in the other 2 it was retrocolic in position. The retro-anastomotic hiatus in the antecolic anastomosis of both gastro-enterostomy and partial gastrectomy has similar boundaries. Anteriorly, the gap is bounded by the afferent jejunal limb, posteriorly by the colon and its mesentery, and by the ligament of Treitz and afferent limb inferiorly. This gap is fairly large, and depends for its size on the length of the afferent loop of the jejunum. In the retrocolic type the hiatus is bounded anteriorly by the afferent jejunal loop, posteriorly by the base of the transverse mesocolon and posterior parietal peritoneum, inferiorly by the ligament of Treitz and jejunal loop, and by the

transverse mesocolon and anastomosis superiorly. This hernia behind the afferent limb is sometimes named after Peterson (1900), who first described it in reporting 3 cases.

Cannon and Weeks (1953) reported 2 similar cases of internal herniation, the first following a retrocolic gastrectomy and the second occurring 12 years after a posterior gastro-enterostomy. In each case a loop of small intestine had passed from the

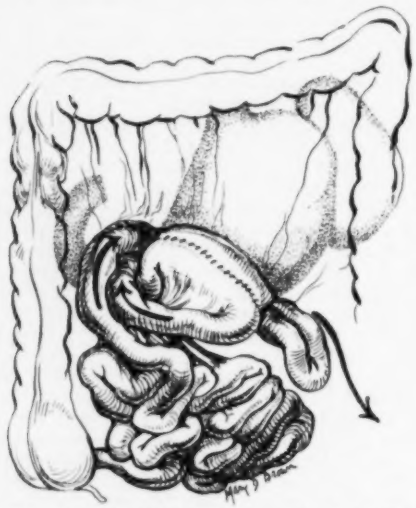

FIG. 381.—Drawing illustrating internal herniation through retro-anastomotic gap following retrocolic partial gastrectomy. Small intestine can pass through this gap, from right to left, as indicated by the arrows, or from left to right.

right to the left behind the afferent limb of the jejunum. They reviewed 60 cases following gastro-enterostomy, 50 of which were of the posterior type. They stress the high mortality-rate of this complication and say that it is in the region of 90 per cent. They advocate prevention by suturing the afferent loop to the posterior parietal peritoneum and transverse mesocolon, between the ligament of Treitz and the gastrojejunal anastomosis, thereby closing the dangerous gap. They point out that in gastric resections it is very important to make a short afferent loop, and if angulation is produced it is apt to occur at the ligament of Treitz. This can be avoided by dividing this fold in the posterior parietal peritoneum and slightly mobilizing the duodenojejunal flexure. Care must be taken to make sure that no undesirable angulation is produced in the afferent loop once the retraction necessary for exposure is released. They make the interesting observation that in some patients it is possible to free the ligament of Treitz enough so that there is no intraperitoneal afferent loop, and hence no gap to close. Armitage (1930) illustrates resection of the ligament when performing a posterior gastro-enterostomy, and describes the peritoneal attachment to the jejunum of at least 1½–2 in. distal to the duodenojejunal flexure in a well-developed ligament. This procedure allows the stoma to lie as near as possible to the flexure. Mobilization of the proximal jejunum in this way, and passing it through the posterior part of the transverse mesocolon, was carried out in the 502 retrocolic gastrectomies reviewed in this communication. It is suggested that if this method is adopted, the short afferent loop will lie closely approximated to the posterior parietal peritoneum, and, as Cannon and Weeks showed, there will be no retro-anastomotic gap to close. No cases of herniation through this gap were found in this series, although it would appear from the literature that this is the commonest type of herniation following a retrocolic anastomosis (McAllister, 1948; Cannon and Weeks, 1953; Dunlop, 1954; Tanner, 1954; Morton and others, 1955). Small intestine can prolapse either from right to left (*Fig.* 381), or left to right, through the gap, although according to reported cases the former occurs more often.

Afferent loop obstruction or strangulation is more frequent in the antecolic type, especially if the loop is long. West (1953) describes 3 cases which are fairly typical of this type of obstruction. The long afferent loop rotates behind the efferent loop, with resulting torsion and angulation of the jejunum at the point of attachment to the lesser curvature of the stomach. The loop can become strangulated, gangrenous, and may perforate (Smith, 1953).

Clinical Symptoms and Signs.—The diagnosis of obstruction due to internal herniation can be difficult, and symptoms and signs may appear at any time from the first few post-operative days up to twenty years after. Professor Stammers suggests that the commonest time of onset is between the third and sixth post-operative days. Afferent loop obstruction or strangulation is characterized by continuous epigastric pain, usually accompanied by the vomiting of gastric contents, but no bile. Physical signs are less characteristic, but there may be epigastric tenderness and guarding, and a mass may be palpable in a thin individual. Shock and prostration may be dominant features.

A plain radiograph may help in the diagnosis, and Hajdu, Harris, and Ramsay (1956) believe that a soft-tissue mass in the upper abdomen is significant, particularly in the absence of pathological fluid levels. The high mortality-rate in this type of obstruction is undoubtedly due to the varied and often misleading symptoms and signs. Perry (1954) reported a case which developed the clinical picture, including laboratory findings, typical of acute pancreatitis, on the thirteenth day following an antecolic gastrectomy. A post-mortem examination revealed that the long afferent loop had strangulated behind the efferent loop. A barium-meal examination had shown that no opaque material had entered the proximal loop, which should have been viewed with suspicion when associated with the clinical signs. Barium radiography can be of help in diagnosis, especially if the plain film findings are equivocal.

Obstruction of the efferent loop of intestine can occur at any point just distal to the stoma, as far as the terminal ileum, and the clinical symptoms and signs may vary according to the level of obstruction. As in the afferent-loop type, the symptoms are not always characteristic, which again makes the diagnosis difficult. Pain may not be a prominent feature, but if present may be localized or generalized. Vomiting may present at an early or late stage and

the contents usually contain bile, becoming eventually fæculent. Abdominal distension may be present, together with generalized tenderness, which may be rebound, and 2 of the cases described here presented in this manner. Localized tenderness and guarding suggest strangulation, and when gangrene develops there are signs of a spreading peritonitis.

Professor Stammers points out that the difficult case to diagnose is the one in which the bowel is not really obstructed, or only intermittently so, and where pain and the feeling of fullness is relieved by vomiting. He suggests that these may be cases which reduce themselves, and that some patients complaining of periodic attacks of pain and vomiting may have intermittent small-bowel obstruction. In contrast to the afferent-loop type, a barium-meal and follow-through examination may demonstrate a definite obstruction. If the opaque material does not show good progress through the efferent loop and if there is pain and vomiting, then a fairly confident diagnosis of obstruction, probably due to herniation, can be made, and laparotomy should be carried out.

Differential Diagnosis.—Most surgeons, at some time or other, have encountered obstruction of the exit stoma, and a great deal has been written on this subject. Causes include stomal œdema, excessive cuff formation at the suture line, pressure of the transverse mesocolon on the jejunal loops, hæmatoma formation and infection around the anastomosis, gastric atony, omental adhesions, and so on. In discussing the mechanism of stomal dysfunction, Prohaska, Govostis, and Kisteens (1954) believe that poor emptying is due to the position of the exit stoma, which allows the small gastric remnant to act as a pouch which, kept filled by gravity, impinges on the exit stoma. To prevent this complication they fashion the gastrojejunostomy in the most dependent portion of the stomach. Attention was drawn to this by Moynihan (1914), who advised making a vertical anastomosis in the posterior wall of the stomach ending below at the lowest point of the greater curvature. Sachs (1955) discusses these factors, but believes that most cases of poor emptying gastrojejunal stomas are not actually mechanical obstructions. It is well known that nearly all cases of early post-operative vomiting respond to the conservative treatment of gastric suction and intravenous fluid and electrolyte replacement. The difficulty arises in distinguishing functional from mechanical obstructions, and for how long conservative measures should be carried out. Herrington (1958) reported 8 patients with stomal obstruction in 209 Polya type gastrectomies, but 5 of these recovered without operation. In the same series 7 cases occurred in 107 Billroth I gastrectomies, and 5 of these were explored.

Abbott, Krieger, and Levey (1958), in discussing the technical factors enhancing or minimizing post-gastrectomy abnormalities, found in their experience that obstruction of the stoma and the part just distal to it occurred less frequently following a gastro-duodenal than a gastrojejunal anastomosis. They conclude that the internal diameter of the stoma should probably not exceed 2 cm.

It should be remembered that a retrograde jejunogastric intussusception is just as likely to occur following a gastrectomy as a gastro-enterostomy (Smith, 1955). The appearance of blood in the vomit usually confirms the diagnosis (Addison, 1958), and a barium meal may demonstrate this abnormality.

Golden (1952) described an interesting condition of functional efferent loop obstruction occurring in a small percentage of cases. During the second post-operative week a feeling of fullness and nausea and vomiting may occur, which usually disappears after a few days on gastric suction. He found on X-ray examination that there was spasm of the efferent loop, with delay in emptying of the stomach remnant. He believes that the spasm is due to a localized temporary disturbance in smooth-muscle function, resulting from surgical trauma to the jejunum in making the anastomosis. The syndrome appears to develop less frequently when there is a short incision in the jejunal wall.

Staphylococcal enteritis can lead to early post-operative vomiting, sometimes associated with abdominal pain, distension, and profuse diarrhœa. This condition requires early recognition, as it may prove rapidly fatal unless prompt intravenous fluid and electrolyte replacement is carried out.

Kay, Richards, and Watson (1958), in discussing acute necrotizing enterocolitis following gastrectomy, say that the clinical diagnosis between this condition and a high small-bowel obstruction after gastrectomy is difficult, and advise immediate laparotomy. The typical clinical picture of necrotizing enterocolitis is that of a patient who, on the second to fifth day after operation, has developed acute peripheral circulatory failure, with minimal abdominal signs and occasional diarrhœa.

In taking the history of a patient who develops symptoms of obstruction, it is worth while ascertaining the nature of the food previously consumed, especially if the individual concerned has been living a normal life since operation. Undigested foodstuffs, especially vegetable matter, can obstruct the bowel, and patients who are edentulous or have badly-fitting false teeth are possibly predisposed to this complication. During the last decade there have been 11 papers published on this condition, and there must be very many more unreported cases. During 1958, 3 cases were operated upon in this hospital, and 2 more were personally encountered at another hospital in Leeds during the previous three years. Spurzem and Desser (1957) reported 2 cases, and in reviewing the world literature found that citrus fruits, especially oranges, are the main offending foodstuffs. Obstruction usually occurs in the terminal ileum, and the bolus of food can often be broken up by the fingers and squeezed through the ileocæcal valve into the large intestine. Sometimes this is not possible, and enterotomy is necessary to relieve the obstruction. Of 5 cases encountered, an enterotomy was carried out in 1 case, the phytobezoar being orange pith in 4 of the 5 cases. In conclusion, it should be remembered that obstruction due to food can occur in an individual with a normal stomach, and Ward-McQuaid (1950) reviewed 178 cases caused by 45 different foodstuffs.

Other acute abdominal conditions which may simulate small-bowel obstruction are appendicitis, cholecystitis, pancreatitis, and large-bowel obstruction. In the series of 535 gastrectomies, 1 man developed pain and vomiting five years after operation,

and clinical and radiological findings suggested a high small-bowel obstruction. Internal herniation was considered in the diagnosis, but at operation he was found to have a large-bowel obstruction due to a carcinoma of the ascending colon, which was successfully resected.

Aetiology.—In considering the cases of obstruction reported on in this communication, it seems significant to the author that all 3 patients were extremely thin individuals. In each case it was noted that the transverse mesocolon was deficient of extraperitoneal fatty connective tissue, and consisted almost entirely of two layers of serous membrane containing the colonic blood-vessels. It is suggested that during division of the gastrocolic omentum prior to resection it is not uncommon for the mesocolon to sustain a small tear, and, if this is not recognized and closed, the resultant damage may produce a definite defect, through which the small bowel may herniate. In *Case* 1 a transmesenteric prolapse occurred on three separate occasions, at 10 days, 3 years, and 3½ years, respectively, after operation. It is further suggested that recurrence of this type of herniation illustrates the difficulty in repairing such a defect in a thin mesentery. In *Case* 3 the bowel prolapse was actually through the opening in the mesocolon adjacent to the anastomosis, and this again might be explained on the same grounds. Why herniation should take place ten years after gastrectomy remains a mystery. This patient actually gave a history of periodic attacks of epigastric fullness relieved by vomiting small amounts of bile. These attacks came on in the morning and he had suffered from them since the time of his operation. Eight years previously a barium-meal and follow-through examination had revealed no abnormality. It is conceivable in this case that an internal hernia had existed over a period of many years, and that acute obstruction had only developed on this one occasion. Morton, Aldrich, and Hill (1955) discussed the aetiology of herniation following gastrectomy, and they suggest that altogether it seems probable that 'happenstance' controls its occurrence, just the right combination of peristaltic wave, posture, relative pressures in various parts of the abdomen, outside pressure, and perhaps other things less obvious. They assumed that any factor or factors more constant than 'happenstance' would be reflected in the frequency and the incidence of herniation.

Abdominal injury may play a part in initiating an internal hernia, and Mock and Mock (1958) found 12 cases associated with it in 159 cases of transomental and mesenteric hernia, but conclude that herniation is rarely caused by trauma.

Prophylaxis.—

1. *Antecolic Anastomosis.*—The prevention of afferent loop obstruction or strangulation would seem to depend primarily on the formation of as short a loop as possible, Stammers (1957) advocating a maximum length of 15 cm. He points out that some people have argued that a long afferent loop has the advantage that the retro-anastomotic gap so formed is sufficiently large to allow any herniating loop of gut to slip out again without mechanical embarrassment. On the other hand the long loop is in greater danger of herniating itself and becoming gangrenous. In the treatment of afferent loop obstruction, anastomosis between afferent and efferent loops will prevent recurrence of this complication.

Efferent loop herniation through the retro-anastomotic gap can be prevented by suturing the afferent loop to the transverse colon and its mesentery. This is advocated by many authors, but it is very doubtful whether this procedure is routinely carried out throughout the world, and in fact Warren (1954) does not think that it is easy to obliterate the gap.

2. *Retrocolic Anastomosis.*—Closure of the mesocolic opening is an accepted necessity, and only one

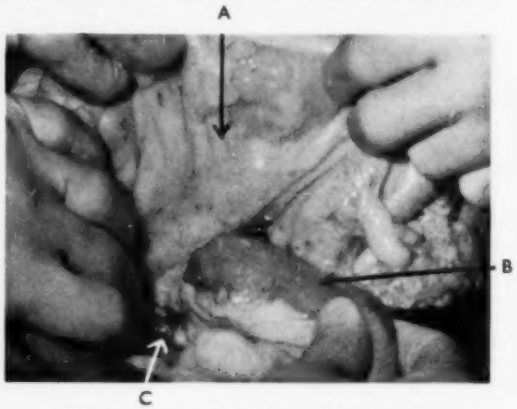

FIG. 382.—Photograph showing position of anastomosis immediately following the completion of a retrocolic partial gastrectomy illustrating: A, Transverse mesocolon; B, Efferent loop attached to greater curvature; C, Very short afferent loop, after mobilization of the proximal jejunum.

or at the most two sutures need be inserted at the level of the anastomosis on the greater curvature of the stomach. It would appear from the numerous diagrams in reported cases of herniation that the mesocolon is attached to the stomach proximal to the anastomosis, and several stitches are inserted on both anterior and posterior walls. This procedure is presumably carried out in order to prevent stomal obstruction due to pressure by the mesocolon. It is suggested that this manœuvre, even if there is a short afferent loop, creates a larger retro-anastomotic hiatus, through which the efferent loop may prolapse. As previously mentioned here, if a short afferent loop is adopted following mobilization of the proximal jejunum, there should be no gap to close, and thus no risk of internal herniation (*Fig.* 382).

Finally, in both types of anastomosis it is advisable to close any defects in the mesocolon that may have been accidentally produced, especially in a thin person.

Treatment.—In the management of early post-gastrectomy vomiting the need for gastric suction and intravenous fluid replacement is obvious and of paramount importance. It is sometimes difficult, however, to decide for how long these measures should be carried out. Continuous suction for 48 hours usually relieves functional stomal obstruction. If vomiting persists after the aspirating tube has been removed, it is probably advisable to repeat the process for a further period of 48 hours. It is important to ensure that the fluid and electrolyte balance are

accurately maintained, and to correct any anæmia or plasma-protein deficiency. A plain radiograph of the abdomen may help in elucidating the cause of the obstruction, and if this does not prove to be of help, a barium-meal examination can be invaluable and may often be diagnostic.

The advent of severe pain, tenderness and guarding, a rising pulse-rate, shock, hæmatemesis, and distension should make one strongly suspicious of mechanical obstruction or strangulation, and at this juncture everything is to be gained by early exploration.

SUMMARY AND CONCLUSIONS

Three cases of intestinal obstruction due to internal herniation following partial gastrectomy are described. In each instance the anastomosis was of the retrocolic type, and a prolapse of the small intestine occurred through a defect in the transverse mesocolon.

In 2 cases the mesenteric defect was separate from the opening through which the gastrojejunal anastomosis passed, but in 1 case it was adjacent to the anastomosis.

Case 1 was remarkable in that this complication occurred on three separate occasions at 10 days, 3 years, and 3½ years, respectively, after the original operation. On each occasion the patient was operated upon and the obstruction successfully relieved.

It seemed significant that all three patients were extremely thin, and that the transverse mesocolon contained no extraperitoneal connective tissue. It is suggested that a small tear, which is more likely to occur in a thin and flimsy mesocolon, may predispose to a prolapse of the small intestine through this mesentery.

Obstruction due to internal herniation after partial gastrectomy is fortunately a rare complication, but important enough to be considered in the differential diagnosis of post-gastrectomy vomiting or any other acute abdominal condition following this operation.

The world literature on this subject is reviewed, and it would appear that the commonest type of herniation complicating both the antecolic and retrocolic anastomosis occurs through the so-called retro-anastomotic hiatus, behind the afferent loop.

The clinical symptoms and signs of this type of obstruction are discussed, and it is pointed out that this complication can occur at any time from immediately after the gastrectomy up to 20 years afterwards.

Certain technical procedures are discussed in order to prevent internal herniation, and in the retrocolic type a short afferent loop, following mobilization of the proximal jejunum, is advised.

I wish to thank Professor Digby Chamberlain for allowing me to review cases under his care, and for his advice. I also thank Mr. Michael C. Oldfield for his permission to report *Case* 1. I am indebted to Miss Mary Brown for the drawings.

REFERENCES

ABBOTT, W. E., KRIEGER, H., and LEVEY, S. (1958), *Amer. J. Surg.*, **148**, 567.
ADDISON, N. V. (1958), *Gastroenterology*, **34**, 1150.
ARMITAGE, G. (1930), *Brit. J. Surg.*, **18**, 154.
CANNON, J. A., and WEEKS, W. H. (1953), *Ann. Surg.*, **138**, 772.
CASE, T. C. (1958), *Amer. J. Surg.*, **96**, 129.
DUNLOP, H. W. (1954), *Canad. med. Ass. J.*, **70**, 314.
EASTMANN, W. H., and COLE, W. H. (1949), *Arch. Surg., Chicago*, **59**, 768.
GOLDEN, R. (1952), *J. Amer. med. Ass.*, **148**, 721.
HAJDU, N., HARRIS, M. A., and RAMSAY, G. S. (1956), *Brit. J. Radiol.*, **29**, 418.
HANSMANN, G. H., and MORTON, S. A. (1939), *Arch. Surg., Chicago*, **39**, 973.
HARRIES, D. J. (1938), *Brit. J. Surg.*, **25**, 915.
HERRINGTON, J. L. (1958), *Surgery*, **44**, 1040.
HIBNER, R., and RICHARDS, V. (1958), *Amer. J. Surg.*, **96**, 309.
KAY, A. W., RICHARDS, R. L., and WATSON, A. J. (1958), *Brit. J. Surg.*, **46**, 45.
MCALLISTER, F. F. (1948), *Ann. Surg.*, **128**, 1194.
MAYO, C. W., STALKER, L. K., and MILLER, J. M. (1941), *Ibid.*, **114**, 875.
MIMPRISS, T. W., and BIRT, St. J. M. C. (1948), *Brit. med. J.*, **2**, 1095.
MOCK, C. J., and MOCK, H. E. (1958), *Arch. Surg., Chicago*, **77**, 881.
MORTON, C. B., ALDRICH, E. M., and HILL, L. D. (1955), *Ann. Surg.*, **141**, 759.
MOYNIHAN, B. G. A. (1914), *Abdominal Operations*, **1**, 180. London and Philadelphia: W. B. Saunders Co.
PERRY, T. (1954), *Ann. Surg.*, **140**, 119.
PETERSON, W. (1900), *Arch. klin. Chir.*, **62**, 94.
PROHASKA, J. V., GOVOSTIS, M. C., and KISTEENS, A. (1954), *Arch. Surg., Chicago*, **68**, 491.
QUINN, W. F., and GIFFORD, J. H. (1950), *Calif. Med.*, **72**, 18.
SACHS, A. E. (1955), *Arch. Surg., Chicago*, **70**, 443.
SMITH, F. (1953), *Lancet*, **1**, 421.
SMITH, I. (1955), *Brit. J. Surg.*, **42**, 654.
SMITH, R. (1945), *Ibid.*, **33**, 187.
SPURZEM, R. R., and DESSER, P. L. (1957), *Surgery*, **42**, 493.
STAMMERS, F. A. R. (1954), *Brit. J. Surg.*, **42**, 34.
— — (1957), *Ibid.*, **44**, 358.
TANNER, N. C. (1954), *Postgrad. med. J.*, **30**, 448.
WARD-MCQUAID, J. N. (1950), *Brit. med. J.*, **1**, 1106.
WARREN, R. P. (1954), *Ann. Surg.*, **139**, 202.
WEST, J. P. (1953), *Surgery*, **34**, 98.

SECONDARY CARCINOMA OF THE PENIS FROM CARCINOMA OF THE BLADDER

By THOMAS J. DEELEY and ROBERT MORRISON

M.R.C. RADIOTHERAPEUTIC RESEARCH UNIT, HAMMERSMITH HOSPITAL, LONDON

THE penis is rarely involved by secondary carcinoma. In most of the cases recorded the site of the primary tumour was either the prostate, the bladder, or the rectum, although primaries at other sites have also been reported (Kaufman and Kaplan, 1956). In a review of the literature 22 cases are recorded of a secondary carcinoma occurring in the penis from a primary growth in the bladder (*Table I*).

Out of 385 patients with carcinoma of the bladder treated at this centre between 1953 and 1958 and attending for follow-up, 4 developed secondary deposits in the penis. Details of these cases are given below.

CASE REPORTS

Case 1.—E. A., male, aged 60 years. At cystoscopy a large growth was seen involving the base and left wall of the bladder and on rectal examination there was extension into the prostate. Biopsy showed an undifferentiated spheroidal-cell carcinoma, but a few fragments of the carcinoma showed a papillary-type neoplasm with squamoid areas. A radical course of X-ray therapy was given.

FIG. 383.—*Case* 4. Secondary carcinoma of the penis causing angulation of the organ.

One month later the patient attended with a lesion of the glans penis which was almost completely replaced by a sloughing infected mass about 3 cm. in diameter. There was a separate nodule in the prepuce about 1 cm. in diameter. A biopsy showed a carcinoma with the same histological features as the bladder tumour. Treatment was given by X-ray therapy, but there was no regression of the tumour and the penis became indurated throughout most of its length. The patient died two months later.

Case 2.—F. E., male, aged 65 years. Cystoscopy revealed an ulcerated carcinoma involving the posterior wall and base of the bladder. There was extravesical spread on both sides of the pelvis. Biopsy showed a deeply infiltrating anaplastic carcinoma. Treatment was given by deep X-ray therapy.

Four months after the beginning of treatment the patient developed priapism, and examination of the penis showed a tumour about 10 × 4 cm. involving the whole organ from the base to about 0·5 cm. from the glans. On urethroscopy nodules were seen along the whole length of the urethra, but no recurrence was present at the primary site. Palliative X-ray therapy was given to the penis with no improvement. Six months later the patient developed metastases in the spine and died.

Case 3.—A. P., male, aged 49 years. Cystoscopy revealed a papilliferous tumour on the lateral wall of the bladder measuring 5 × 5 cm. The base of the bladder was not involved. A partial cystectomy with re-implantation of the right ureter was performed. Histologically the tumour was a transitional-cell carcinoma.

Recurrences which developed were treated by X-ray therapy and a total cystectomy was later required. Three years after the first treatment secondaries developed in the shaft of the penis and an amputation was performed. The patient died 15 months later with widespread disease in the pelvis.

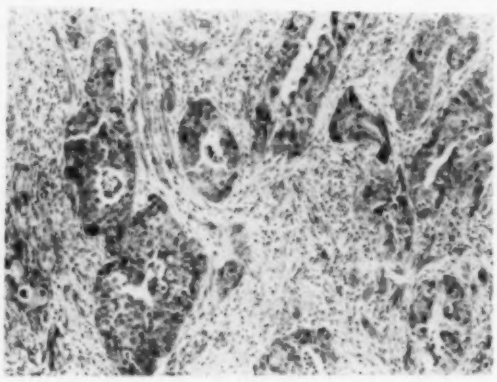

FIG. 384.—*Case* 4. Section of corpus cavernosum showing cavernous spaces containing carcinoma cells.

Case 4.—F. F., male, aged 65 years. Cystoscopy revealed a sessile bladder tumour above the right ureteric orifice. There was induration of the right side of the pelvis out to the pelvic wall. Biopsy showed an undifferentiated spheroidal-cell carcinoma, in places having a squamoid appearance and invading the muscle. Treatment was given by deep X-ray therapy.

Two months after the beginning of treatment the patient developed priapism, and on examination of the penis there was nodular thickening at the base and proximal half of the penis and two separate smaller nodules in the corpora cavernosa distally (*Fig.* 383). One of the nodules was removed and showed a similar histological picture to the original lesion (*Fig.* 384). Treatment was given by deep X-ray therapy, with no improvement. The patient died three months later.

DISCUSSION

It might be expected that spread to the penis would be commoner when the primary growth involved the base of the bladder and the prostate. In many of the cases reported and in two of our own, however, secondaries developed in the penis without the base being involved. Most of the tumours were of a high grade of malignancy and the penile secondaries usually appeared within a few months. The exceptions were 3 cases reported by Paquin and Ruland (1956) in which there was an interval of three, eight, and twelve years. In one of our cases there was an interval of three years, but during this time recurrences developed at the primary site.

In 11 out of 26 cases the metastases caused the patient to complain of priapism, and in 3 patients the penile swelling was the first symptom of the bladder growth. In the majority of patients the lesion first

Table I.—RECORDS OF SECONDARY CARCINOMA OF THE PENIS FROM PRIMARY BLADDER CARCINOMA

AUTHOR AND DATE	AGE (yr.)	SITE OF PRIMARY	HISTOLOGY OF PRIMARY	TREATMENT GIVEN TO PRIMARY	INTERVAL BETWEEN TREATMENT OF PRIMARY AND DEVELOPMENT OF METASTASES	SURVIVAL AFTER SECONDARIES DEVELOPED
Neumann, 1882	50	Base	?	?	?	Found post mortem
Paschkis, 1929	37	Base	Papillary carcinoma	Partial resection	?	3 d.
Kessel, 1934	39	Right lateral wall	Malignant papilloma	Cystotomy	2 wk.	2 mth.
Peacock, 1938	?	Left lateral wall	Squamous	Diathermy	2 yr.	6 wk.
Wattenberg, 1944	56	Right lateral wall	Squamous transitional	Radiotherapy	3 mth.	?
Melicow and Ganem, 1946	?	?	?	?	?	?
Musiani, 1947	47	Base	Spindle cell	Cystotomy	At same time	3 d.
Baker, 1950	57	Base-trigone	Squamous	Transurethral resection	8 mth.	1 mth.
	54	Base	Papillary carcinoma	Cystotomy and resection	6 mth.	6 mth.
	72	Urachal attachment	Anaplastic	Segmental resection	3 mth.	5 mth.
	58	Lateral wall	Moderate malignant infiltration	Coagulation diathermy	4 mth.	4 mth.
Fort, Bailey, Kicklighter, 1951	77	Left lateral wall	Transitional	—	At same time	Alive
Berard and Byrne, 1953	68	Base	Squamous	Refused	3 mth.	2 mth.
Poutasse, 1954	70	Whole bladder	Transitional	Radiotherapy	2 mth.	3 mth.
	71	Anterior	Squamous	Segmental resection	2 mth.	1 mth.
Hamm and Weinberg, 1955	64	Right lateral wall	Squamous	—	At same time	2 mth.
Paquin and Ruland, 1956	49	?	Transitional	Repeated fulgurations	8 yr.	6 mth.
	63	?	Transitional	?	3 yr.	2 wk.
	73	?	Transitional	Fulgurations, segmental resection, total cystectomy	12 yr.	Alive
Kaufman and Kaplan, 1956	60	?	Transitional	Radon seed	6 mth.	Found post mortem
Payne, 1957	69	Lateral wall	Anaplastic	Radiotherapy	At same time	5 d.
Present series	65	Floor and posterior wall of prostate	Anaplastic	Radiotherapy	4 mth.	5 mth.
	60	Left lateral wall	Transitional with squamous	Radiotherapy	1 mth.	2 mth.
	48	Right lateral wall	Transitional	Partial cystectomy, radiotherapy for recurrence, then total cystectomy	3 yr.	14 mth.
	65	Right lateral wall	Anaplastic	Radiotherapy	2 mth.	3 mth.

appeared near the root of the penis. The site of the growth in the penis was the corpus cavernosum in 17, the corpus spongiosum in 5, the glans penis in 2, and the whole penis was involved at the first examination in 2.

Spread to the penis was not associated with any particular method of treatment of the primary. Many of the patients had evidence of metastases elsewhere and the prognosis was invariably bad—survival after the development of this secondary tumour being a few months only.

The possible methods of spread to the penis would seem to be either: (1) direct, (2) arterial, (3) retrograde venous, or (4) retrograde lymphatic.

Direct.—A direct spread may occur to the prostate and thence along the urethra to involve the corpus spongiosum.

Arterial.—This method of spread undoubtedly occurs, because metastases in the penis are recorded from distant sites such as the kidney (Craig, 1941; Burrell, 1948; Henderson, 1950), bronchus (Richter, 1953), and nasopharynx (Markson, Stoops, and Kanter, 1949), but these primary sites are recorded less frequently than bladder, prostate, or rectal primaries.

Retrograde Venous.—There is a communication between the venous sinuses of the corpora cavernosa and the prostatic plexus of veins; the deep dorsal vein also drains into the prostatic plexus (Brash, 1951). It may be postulated that during coughing and straining blood may flow back from the prostatic plexus to the venous sinuses.

Retrograde Lymphatic.—The lymph drainage from the penis is mainly to the inguinal nodes, but small lymphatic vessels follow the deep dorsal vein to join the prostatic lymph-vessels which drain into the deep iliac nodes (Brash, 1951). Retrograde spread may occur along these small vessels when the prostatic vessels are occluded by growth.

CONCLUSIONS

The appearance of a penile secondary from a bladder carcinoma is of grave prognostic significance. In all the cases reported the patients died within a few months of the appearance of the secondary. In most cases the cause of death was widespread metastatic disease. X-ray treatment has been tried as a palliative measure, but in our experience a poor response is obtained.

SUMMARY

Four cases of secondary carcinoma in the penis from a primary bladder carcinoma are described and the literature reviewed.

Possible methods of spread of the disease to this site are given.

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REFERENCES

BAKER, W. J. (1950), *J. Urol.*, **63**, 618. In discussion of Dean and Ash's paper.
BERARD, L. N., and BYRNE, J. E. (1953), *Ibid.*, **70**, 261.
BRASH, J. C. (1951), *Cunningham's Text-book of Anatomy*, 9th ed. London: Oxford University Press.
BURRELL, N. L. (1948), *J. Urol.*, **60**, 636.
CRAIG, L. G. (1941), *Calif. west. Med.*, **55**, 135.
FORT, C. A., BAILEY, M. K., and KICKLIGHTER, J. E. (1951), *J. Urol.*, **66**, 238.
HAMM, F. E., and WEINBERG, S. R. (1955), *Ibid.*, **73**, 349.
HENDERSON, D. St. C. L. (1950), *Brit. J. Urol.*, **22**, 223.
KAUFMAN, J. J., and KAPLAN, L. (1956), *Arch. Surg., Chicago*, **73**, 105.
KESSEL, J. S. (1934), *J. Urol.*, **32**, 213.
MARKSON, L. S., STOOPS, C. W., and KANTER, J. (1949), *Arch. Derm. Syph., Chicago*, **59**, 50.
MELICOW, M. M., and GANEM, E. J. (1946), *J. Urol.*, **55**, 486.
MUSIANI, U. (1947), *Urologia Treviso*, **14**, 94.
NEUMANN, I. (1882), *Medizinische Jahrbücher*, **38**, 143.
PAQUIN, A. J., and RULAND, S. I. (1956), *Cancer*, **2**, 626.
PASCHKIS, R. (1929), *Z. urol. Chir.*, **26**, 154.
PAYNE, R. A. (1957), *Brit. J. Urol.*, **29**, 58.
PEACOCK, A. H. (1938), *Northw. Med., Seattle*, **37**, 143.
POUTASSE, E. F. (1954), *J. Urol.*, **72**, 1196.
RICHTER, H. (1953), *Zbl. allg. Path. path. Anat.*, **90**, 24.
WATTENBERG, C. A. (1944), *J. Urol.*, **52**, 169.

ADENOACANTHOMA OF THE PYLORUS
A REPORT OF A CASE

BY R. COX AND D. H. MACKENZIE
WESTMINSTER HOSPITAL, LONDON

ROLLESTON and Trevor (1905) under the title "Columnar-celled Carcinoma of the Stomach showing Squamous-celled Metaplasia" described for the first time a rare tumour of the pylorus made up of squamous and adenocarcinomatous elements. Since then a number of other cases have been reported under various names such as "adenoacanthoma" (Pasternack, 1935), which is most commonly used, "adenocancroid" (Herxheimer, 1907), and "adenosquamous carcinoma" (Rabson, 1936). The present writers have been able to find 16 acceptable cases, and these are shown in *Table* I. Two further cases were mentioned by McPeak and Warren (1948), but no details were given.

The cases described by Boedeker (1927) and O'Brien and Meehan (1950) are not included, as both these patients had malignant tumours of the colon in addition to the gastric neoplasm, which may therefore have been a metastasis. Adenoacanthomas and squamous-cell carcinomas of the colon have

indeed been described (Konwaler, 1954; Hicks and Cowling, 1955). Although this article is mainly concerned with pyloric adenoacanthomas, two further cases must be mentioned. Martin and Pollosson (1936) described an adenoacanthoma of the lesser curve which, though not of pyloric origin, arose some distance from the cardia, while Scheffler and Falk (1940) described a similar tumour arising about 7 cm. from the cardio-œsophageal junction. It should also be noted that the literature contains a number of references (Scheffler and Falk, 1940; Hicks, 1953) to pure squamous-cell carcinomas of the stomach arising at a distance from the cardia. In the absence of any record of serial sections it is clearly impossible to be sure that some of them did not contain unexamined foci of adenocarcinoma.

Table I.—Cases of Adenoacanthoma of the Pylorus reported in the Literature

Case	Author and Date	Sex	Age (yr.)	Special Features
1	Rolleston and Trevor, 1905	F.	39	
2	Lubarsch, 1906			
3	Herxheimer, 1907			
4	Oberling and Wolf, 1927	F.	67	
5	Boedeker, 1927	F.	35	
6		F.	65	
7	Pasternack, 1935	M.	48	Goblet-cell metaplasia and inflammation in stomach wall
8	Wood, 1943	M.	51	
9		M.	37	
10	Strassman, 1946	M.	85	Focus of non-neoplastic squamous epithelium seen in cardia. Chronic hypertrophic gastritis present
11	Milanes, Blanco, and Causa, 1950	M.	50	Marked inflammatory element throughout the tumour
12	Puccini and Stigliani, 1950	M.	58	
13	Bellegie and Dahlin, 1951	M.	42	Patient had gastritis
14		M.	49	
15	Kothare, 1952	M.	50	
16	McShane, 1953	F.	66	

An additional case of pyloric adenoacanthoma will now be described.

CASE REPORT

The patient was an Italian male, aged 65 years. The first symptom was a vague sensation of fullness in the upper abdomen which had been present for five weeks prior to admission to hospital. About a month after the onset he lost his appetite and for four or five days had suffered from increasing breathlessness on exertion. There was no history of loss of weight. The outstanding feature prior and on admission to hospital was extreme pallor and the liver was noted to be enlarged. Hæmatological investigation showed hæmoglobin of 36 per cent and 25 per cent of monocytes. The first diagnosis suggested was monocytic leukæmia, but a sternal puncture failed to confirm this. A barium meal showed appearances which were thought to be those of a carcinoma of the stomach involving the lower two-thirds. There was considerable distortion of the pyloric portion with fixation of the mucosa. A fortnight after admission the patient started to vomit small quantities of blood, and several days later he had a hæmatemesis totalling 1½ pints over a period of three hours.

At this stage he was first seen by one of us (R. C.). Apart from the liver, which was firm, smooth, and enlarged, and the anæmia, there were no physical signs. The diagnosis of carcinoma of the stomach, which was bleeding and causing pyloric stenosis, was made, and it was decided to transfuse the patient with a view to getting him fit for laparotomy. At laparotomy the whole of the distal two-thirds of the stomach was seen to be involved by a large, firm tumour which was invading the peritoneal coat, and the stomach was adherent to the liver. The adhesions were recent, and in the process of separating them a necrotic area of stomach wall about 2 cm. wide was revealed, and this appeared to have allowed some leakage. A frozen section from the tumour unexpectedly revealed squamous carcinoma.

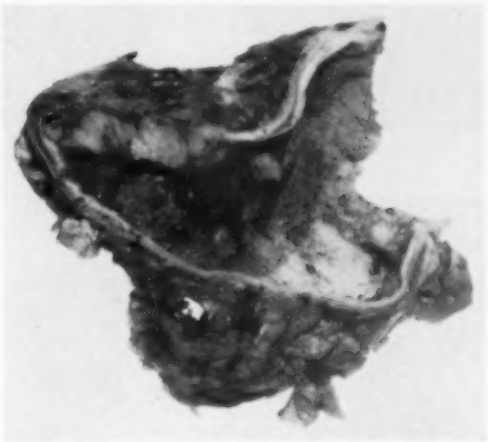


Fig. 385.—Portion of stomach showing extensive pyloric tumour.

The lesion was clearly inoperable, but it was decided to attempt to resect the major portion of the growth in order to palliate the patient's symptoms. This was accomplished and a Polya-type gastrectomy was effected. The resection, however, involved leaving a considerable amount of growth behind, particularly in the region of the head of the pancreas. The closure of the duodenal stump was carried out with tissues which were clearly infiltrated and the abdomen was therefore drained. The immediate post-operative course was satisfactory, but thirty-six hours later the patient complained of some increase of abdominal pain and became collapsed, cold, and sweating, with a blood-pressure of 90/60. This was treated by plasma transfusion and within a few hours the patient's condition improved. Twenty-four hours later there was considerable discharge through the drain and it became clear that the duodenal stump had leaked. Nevertheless, the patient remained in reasonable condition for the next seven days, when his condition again deteriorated rapidly and death soon followed.

At necropsy a considerable mass of residual tumour was found invading both the pancreas and the para-aortic glands. There were no other tumour deposits anywhere. The anastomosis showed little or no attempt at healing, and death was due to massive hæmorrhage from

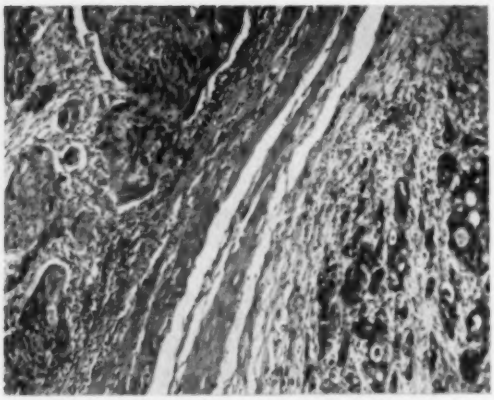


FIG. 386.—Stomach showing both adenocarcinoma and squamous carcinoma. Hæmatoxylin and eosin. (× 30.)

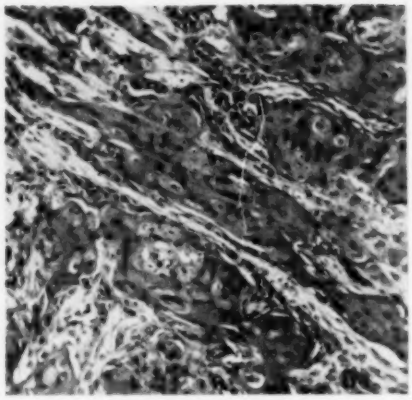


FIG. 387.—An area of squamous carcinoma. Hæmatoxylin and eosin. (× 60.)

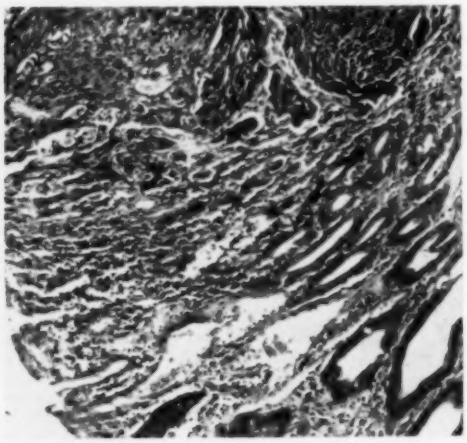


FIG. 388.—Columnar epithelium merging into anaplastic carcinoma. Hæmatoxylin and eosin. (× 66.)

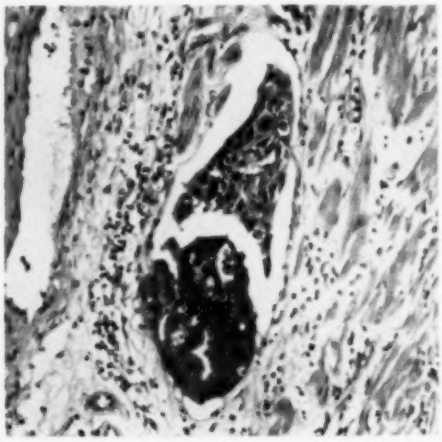


FIG. 389.—Tumour deposit with mixed appearance in stomach wall. Hæmatoxylin and eosin. (× 128.)

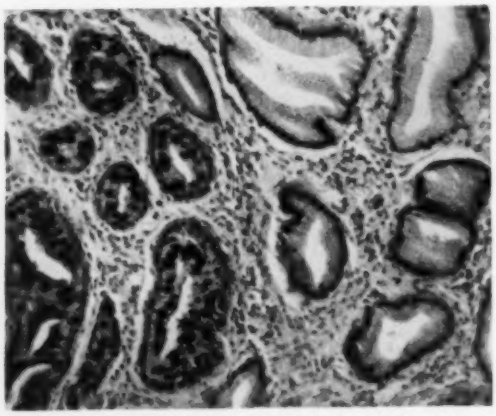


FIG. 390.—Intestinal metaplasia of stomach showing goblet cells to the left of the picture. Mucicarmine. (× 120.)

this site. Histology from the glands and pancreas showed squamous carcinoma only.

OPERATION SPECIMEN.—

Macroscopic Appearance.—The specimen consisted of the distal two-thirds of the stomach. There was a large, ulcerating, foul-smelling tumour arising in the pylorus near the lesser curve (*Fig.* 385). Posteriorly the neoplasm had invaded deep into the pancreas, while anteriorly there was a perforation close to the lesser curve. There was a wide margin of macroscopically normal stomach proximal to the tumour, but immediately adjacent to the growth sub-mucous spread of tumour was observed. The central part of the lesion was very necrotic.

Microscopic Appearance.—Thirty sections were examined from the tumour. The non-neoplastic areas of the stomach were examined by the 'Swiss-roll' method described by Magnus (1937). All sections were stained with hæmatoxylin and eosin and selected ones with phosphotungstic acid hæmatoxylin and Southgate's modification of Mayer's mucicarmine.

The tumour was an adenoacanthoma showing areas of adenocarcinoma and far more extensive areas of squamous carcinoma (*Fig.* 386). Differentiation was variable in both components, but much of the tumour

was made up of moderately differentiated squamous carcinoma (*Fig.* 387). Epithelial pearl formation and intercellular bridges were observed in some areas. The extent of the tumour and the gross necrosis made its exact origin difficult to determine, but in places non-neoplastic gastric mucosa passed directly into anaplastic carcinoma (*Fig.* 388), which in turn merged into both squamous and adenocarcinoma. In addition, it was possible to find occasional fields where adenocarcinoma merged directly into tumour of an anaplastic squamous type. A tumour deposit of mixed type in the muscle coat is shown in *Fig.* 389. The inflammatory element was conspicuous throughout the tumour and inflammatory infiltration of the stomach wall was noted in the non-neoplastic areas. The latter showed extensive intestinal metaplasia (*Fig.* 390) of the type described by Magnus (1937) and Morson (1955).

DISCUSSION

It is characteristic of tumours that they reproduce the tissue of origin to a varying degree. Organs such as the lung, where squamous metaplasia of the epithelium is well known, may produce squamous carcinoma or carcinomas with a mixed pattern. In this connexion Willis (1952) has pointed out that, in certain situations, tumours are by far the most frequent pathological lesions to disclose the dormant metaplastic potentialities of the parent tissue. In places where there are contiguous squamous cell and glandular surfaces, such as the cardio-œsophageal junction, adenoacanthomatous tumours are not particularly uncommon (McPeak and Warren, 1948).

It is far more difficult to explain a squamous element in a pyloric carcinoma. Squamous epithelium, either congenital or metaplastic, has seldom been seen in the stomach (Watson, Flint, and Stewart, 1936; Strassman, 1946) and has never been seen in the pylorus. There are four main theories of origin. The tumours may arise: (1) from embryonic rests of squamous epithelium; (2) from areas of squamous metaplasia; (3) from carcinoma cells of a pre-existing adenocarcinoma; and (4) from undifferentiated cells of the columnar epithelium. In addition, an interesting suggestion was made by Casanova Diaz (1951), who suggested that squamous carcinomas might arise from a thin, flattened epithelial layer, only demonstrable by special fixation methods, which covers the mucous membrane of the stomach, and which has been described by Duran-Jorda (1945, 1947).

In the interests of brevity the arguments for and against these explanations will not be repeated here. A full account of them and of the experimental production of gastric squamous metaplasia in animals can be found in the papers of Herxheimer (1907), Stewart and Lorenz (1942), Wood (1943), Nicholson (1950), Hicks and Cowling (1955), and Lange (1955). The majority of authors favour an origin from less differentiated basal cells which are normally present in the deeper parts of the foveolæ of the gastric mucous membrane.

In the present case no rests of squamous epithelium were observed and the only metaplasia of benign mucosa was of the intestinal type. The direct passing of columnar epithelium into anaplastic carcinoma, and the transition of this into both squamous and adenocarcinoma, strongly support a direct origin from columnar epithelium, and it is reasonable to suppose that the more undifferentiated cells are mainly concerned. The intimate relationship of the two neoplastic patterns in the present case indicated that fully developed adenocarcinoma could also change to the squamous form. In this connexion it is tempting to suggest that the gross inflammation noted in this and other recorded cases may have played a part.

SUMMARY

1. A case of adenoacanthoma of the pylorus is described.

2. The findings support the view that these tumours arise from columnar epithelium and it is suggested that the squamous element may also arise direct from foci of adenocarcinoma.

We are indebted to Dr. W. E. Lloyd for permission to publish this case; and to the Department of Medical Photography, Westminster Hospital.

REFERENCES

Bellegie, N. J., and Dahlin, D. C. (1951), *Proc. Mayo Clin.*, **26**, 70.
Boedeker, F. (1927), *Z. Krebsforsch.*, **24**, 406.
Casanova Diaz, J. R. (1951), *Surgery*, **30**, 554.
Duran-Jorda, F. (1945), *Acta med. scand.*, **123**, 1.
— — (1947), *Surg. Gynec. Obstet.*, **84**, 983.
Herxheimer, G. (1907), *Beitr. path. Anat.*, **41**, 348.
Hicks, J. D. (1953), *J. Path. Bact.*, **66**, 570.
— — and Cowling, D. C. (1955), *Ibid.*, **70**, 205.
Konwaler, B. E. (1954), *Amer. J. Surg.*, **88**, 613.
Kothare, S. N. (1952), *Indian med. Gaz.*, **87**, 105.
Lange, W. G. (1955), *Prensa méd. argent.*, **42**, 241.
Lubarsch, O. (1906), *Verh. dtsch. path. Ges.*, **10**, 198.
McPeak, E., and Warren, S. (1948), *Amer. J. Path.*, **24**, 971.
McShane, K. L. (1953), *J. int. Coll. Surg.*, **19**, 360.
Magnus, H. A. (1937), *J. Path. Bact.*, **44**, 389.
Martin, J. F., and Pollosson, E. (1936), *J. Méd. Lyon*, **17**, 553.
Milanes, F., Blanco, P. L., and Causa, A. (1950), *Gastroenterology*, **15**, 518.
Morson, B. C. (1955), *Brit. J. Cancer*, **11**, 365.
Nicholson, G. W. de P. (1950), *Studies in Tumour Formation*. London: Butterworth.
Oberling, C., and Wolf, M. (1927), *Bull. Ass. franç. Cancer*, **16**, 68.
O'Brien, J. P., and Meehan, D. J. (1950), *Surgery*, **28**, 1005.
Pasternack, J. G. (1935), *Amer. J. Path.*, **11**, 541.
Puccini, C., and Stigliani, R. (1950), *Arch. De Vecchi Anat. pat.*, **15**, 213.
Rabson, S. M. (1936), *Arch. Path. (Lab. Med.)*, **21**, 308.
Rolleston, H. D., and Trevor, R. S. (1905), *J. Path. Bact.*, **10**, 418.
Scheffler, M. M., and Falk, A. B. (1940), *Amer. J. Cancer*, **38**, 359.
Stewart, H. L., and Lorenz, E. (1942), *J. nat. Cancer Inst.*, **3**, 175.
Strassman, G. (1946), *Arch. Path. (Lab. Med.)*, **41**, 213.
Watson, G. W., Flint, E. R., and Stewart, M. J. (1936), *Brit. J. Surg.*, **24**, 333.
Willis, R. A. (1952), *Pathology of Tumours*. London: Butterworth.
Wood, D. A. (1943), *Arch. Path. (Lab. Med.)*, **36**, 177.

MEGACOLON AND VOLVULUS IN PSYCHOTICS

By IVAN D. A. JOHNSTON
SENIOR TUTOR IN SURGERY, QUEEN'S UNIVERSITY, BELFAST
AND J. B. GIBSON
LECTURER IN PATHOLOGY, QUEEN'S UNIVERSITY, BELFAST

Gross dilatation of the colon has been reported in psychotics from time to time (Ehrentheil and Wells, 1955; Burrell, 1957). Repeated enemata may prevent or relieve constipation and abdominal distension, but volvulus of a dilated and elongated loop may cause death. This report concerns 3 cases of megacolon and volvulus which occurred recently in Purdysburn Mental Hospital, Belfast, and which were treated by formal resection of the pelvic megacolon.

CASE REPORTS

Case 1.—A man aged 62 years, suffering from a manic depressive pyschosis for twenty-two years, required repeated enemata to empty the bowel and to relieve abdominal distension over a period of seven years, but this measure eventually became ineffective. A barium enema showed the colon to be grossly elongated and distended. When the sigmoidoscope was passed, a narrow œdematous zone was encountered at 25 cm., where the colon was obviously twisted. Passage of a flatus tube through the twisted section at first relieved the patient's distension, but the procedure became increasingly difficult, and finally the twisted loop was resected. At the operation the pelvic colon was found to be about 80 cm. long. It formed a U-shaped loop and was 25 cm. in diameter at the widest part, narrowing at the ends of the loop where it was twisted. The bowel was thick and leathery in texture. An injection of 2 ml. of a 0·1 per cent solution of nicotine into the inferior mesenteric artery was not followed by any contraction of the dilated segment, which suggested that there had been atrophy of the ganglion cells. The resection was completed by an end-to-end anastomosis. The patient's bowels have functioned normally during the eighteen months after operation.

Examination of the resected portion of colon showed that the thickening of the wall was due chiefly to muscular hyperplasia. A complete longitudinal strip of the resected portion of the bowel was examined histologically. Ganglion cells were present in the muscularis and in the mucosa at all levels and abnormalities of innervation were not detected, in spite of the failure to respond to local nicotine as the normal bowel does.

Case 2.—A man aged 74 years suffering from a senile psychosis for six years presented as an abdominal emergency with signs of large-bowel obstruction. Repeated attempts to deflate the bowel by flatus tube and by sigmoidoscopy were unsuccessful and laparotomy was performed. The greater part of the colon, including the pelvic portion, was grossly dilated and had a thick wall. There was volvulus of the pelvic colon and this was untwisted. The patient recovered, but after six weeks, episodes of obstruction recurred and although it was possible to untwist the volvulus by passing a flatus tube, the attacks became so frequent that a staged resection of the pelvic colon with end to-end-anastomosis was carried out. Two months later the patient's bowels were acting normally, but he died suddenly about this time of a cerebral hæmorrhage.

The resected pelvic colon measured 70 cm. in length and 20 cm. in diameter at its widest part, being narrower at each end. It formed a U-shaped loop. The muscle wall was considerably hypertrophied and the texture of the wall was leathery. A few shallow ulcers of the mucosa were present. Histological examination of a complete longitudinal strip of the specimen showed that ganglion cells were present throughout and the innervation was normal in structure.

Case 3.—A man aged 66 years suffering from a senile psychosis for two years presented with large-bowel obstruction which could not be relieved by conservative measures. At an emergency operation the whole of the colon was found to be distended and thick-walled. A volvulus of the pelvic colon was present and this was untwisted. Two ml. of a 0·1 per cent solution of nicotine were injected into an artery supplying the hypertrophied bowel; the bowel did not contract. A drainage tube was left in the lumen of the colon. One week later a staged resection of the pelvic colon was carried out. The patient recovered satisfactorily, and six months after operation his bowel function was normal, but with mental deterioration incontinence of fæces has developed.

The resected portion of the pelvic colon measured 75 cm. long and 15 cm. at its broadest diameter. It resembled the specimens in the previous cases, and ganglion cells were identified at all levels throughout its length.

DISCUSSION

Congenital megacolon or Hirschsprung's disease is due to an absence of ganglion cells from a portion of the gut (Bodian, Stephens, and Ward, 1949), but ganglion cells may be destroyed and replaced by scars containing proliferations of Schwann cells in the course of various diseases of the gastro-intestinal tract (Delage, 1956).

In Brazil an acquired disorder of autonomic function is not uncommon, in which œsophagus, stomach, colon, and ureters are involved. The plexuses of Meissner and Auerbach disappear and megacolon may be encountered. The aetiology of this condition, which shows no predilection for psychotics, is unknown. Raia (1955) favours a dietary deficiency; Delage pointed out that the ganglion cells of the gut may be destroyed in Chagas's disease. These conditions can be distinguished pathologically from the disease in our three cases, in which ganglion cells were found by the technique usually employed in Hirschsprung's disease, at all levels in the resected gut. Although Burrell (1957) has described total absence of ganglion cells from a grossly dilated colon, which caused the death of a schizophrenic woman in the United States, it seems likely that in most cases, at least in this country, megacolon in psychotics originates in a functional and not a structural lesion.

Neglect or complete loss of the bowel habit is common in withdrawn psychotics and provides the most plausible explanation for the development of the condition in our patients. Ehrentheil and Wells (1955) point out that there is no sharp dividing line between megacolon and chronic atonic constipation in psychotics. Long-continued neglect of the bowel is necessary, no doubt, to produce the gross structural alterations which are reported here and by other authors. In *Case* 1 enemata were required over a

period of seven years. The muscular wall of the bowel was considerably hypertrophied in all cases. Whether the lack of any muscular response to the intra-arterial injections of nicotine in two of the cases represented a loss of all power of contraction is uncertain, but it seems unlikely that adequate function could have been restored to the deformed segments of colon resected. Ehrentheil and Wells favour medical rather than surgical treatment, and we do not advocate an early recourse to surgery without qualification, but the operation was successful in breaking a vicious circle of dysfunction and structural change in our cases. The main danger of the condition is recurrent volvulus with intestinal obstruction in the pelvic portion of the dilated colon. The possibility of these complications of megacolon in chronic constipation and the chances of successful surgical treatment should be fully recognized in the care of psychotics.

SUMMARY

Three elderly psychotic patients suffering from intestinal obstruction as a result of volvulus of acquired megacolon were treated by resection of the pelvic colon with favourable results. The pathology and aetiology of the condition are discussed.

Acknowledgement.—We are grateful to Dr. C. B. Robinson, Superintendent, Purdysburn Mental Hospital, for referring the cases.

REFERENCES

BODIAN, M., STEPHENS, F. D., and WARD, B. C. H. (1949), *Lancet*, **1**, 6.

BURRELL, Z. L. (1957), *Gastroenterology*, **33**, 625.

DELAGE, J. (1956), *Ann. anat. path.*, **1**, 451.

EHRENTHEIL, O. F., and WELLS, E. P. (1955), *Gastroenterology*, **29**, 285.

RAIA, A. (1955), *Surg. Gynec. Obstet.*, **101**, 69.

THORACIC KIDNEY
WITH REPORT OF A CASE

BY A. T. S. PAUL AND C. G. URAGODA

THORACIC UNIT, GENERAL HOSPITAL, COLOMBO, CEYLON

AND F. L. W. JAYEWARDENE

DEPARTMENT OF ANATOMY, UNIVERSITY OF CEYLON

HERNIATION of the kidney into the thoracic cage is rare. Robbins and Lich (1954) have been able to collect 11 cases from the literature. Another 4 cases have been traced by us, making a total of 15 cases. Of these, 11 were confined to herniation of the kidney alone, and 4 were herniations of the kidney together with other abdominal viscera, namely, stomach, colon, omentum, and spleen. A personal case of congenital right-sided thoracic kidney is reported here.

CASE REPORT

H. A. P., male, a trader, aged 26 years, was admitted on May 6, 1957 to the Thoracic Unit of the General Hospital, Colombo, with a complaint of pain in the right side of the chest of eight years' standing. The pain was of a dull nature and came on once or twice a month. It was of short duration, lasting half an hour each time. It was not increased by breathing or coughing. There was no radiation of the pain. The patient was afebrile and had no cough.

He had been previously treated on several occasions in a medical ward on a diagnosis of amœbic hepatitis. There was no history of injury.

On examination no physical signs referable to the chest were found. X-ray examination showed the right dome of the diaphragm elevated in the postero-anterior film (*Fig.* 391). The right lateral film showed a hemispherical mass in the posterior and middle mediastinum (*Fig.* 392). The upper margin was continuous with the diaphragmatic shadow. The lower limits of the mass could not be separated from the liver shadow. A provisional diagnosis of diaphragmatic hernia was made, and also a barium follow-through examination of the gastro-intestinal tract in the Trendelenburg position. This, however, showed no abnormality. An exploratory thoracotomy was decided on as the diagnosis was obscure.

Under nitrous oxide and oxygen anæsthesia with controlled respiration, exploration of the right side of the chest was made through the bed of the seventh rib. The lower lobe of the lung was found to be smaller than the upper or the middle lobes. Although small, it was not

FIG. 391.—Postero-anterior radiograph of the chest showing the elevated right dome of the diaphragm.

atelectatic. The diaphragm was found to be elevated over the site of the pleuroperitoneal hiatus.

The protrusion was covered with a thin membranous layer. The edges of this defect were thickened. On incising the membranous covering the right kidney was

found to be covered with extraperitoneal fat. No adrenal was seen above the kidney. At this stage it was decided to reduce the herniation of the kidney by plication of the diaphragm. Complete refixation of the kidney in its normal anatomical position was not attempted at the time as we had no knowledge of the position of its pelvis and ureter, or whether there was even a normal left kidney present.

The patient made an uneventful recovery and before he was discharged from hospital on July 6, 1957 intravenous and retrograde pyelography and cholecystography were performed.

The pyelograms revealed that the right kidney was higher than the left (*Fig.* 393). The pelvi-caliceal pattern on the right side was normal, except for the fact that the right upper calix was elongated. The intravenous pyelogram showed that the right kidney was larger than the left. Both kidneys excreted the dye.

The cholecystogram showed a functioning gall-bladder, but it was slightly elevated in position.

The patient has been seen at intervals and has been free of symptoms since the operation. At no stage, either pre- or post-operatively, has he had any symptoms referable to the urinary tract.

FIG. 392.—Right lateral radiograph showing the hemispherical mass in the posterior and middle mediastinum.

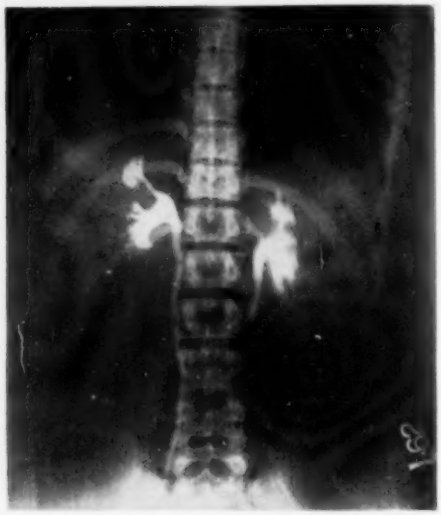


FIG. 393.—Retrograde pyelogram showing the right kidney at a higher level than the left.

DISCUSSION

Eleven cases of herniation of the kidney as the sole abdominal viscus herniated into the thoracic cage have been reported in the literature. Of these 4 were post-traumatic, and therefore do not fall into the group under discussion. This is the eighth case of congenital herniation of the kidney into the thoracic cage to be reported.

The Defect in the Diaphragm.—The patient gave no history of injury and the observed defect in the diaphragm may be presumed to be of congenital origin. The defect, which appeared as a thinned-out membrane in the area of the lumbocostal trigone, formed a sac for the herniating kidney. There was no free communication between the pleural and the peritoneal cavities, leaving us to infer that the closure of the pleuroperitoneal openings had already been effected.

Factors favouring Herniation.—While there is general agreement that a diaphragmatic deficiency, either of congenital or traumatic origin, must be present for herniation to occur, there are several other factors which do not always receive their due share of recognition.

The upper half of the trunk encloses a cavity with rigid walls, in contrast to the pliant and compressible walls of the lower half. At the junctional region the diaphragm is attached all round the unyielding periphery to separate the two cavities. Below this the cavity of the upper abdomen deepens and widens on either side of the midline.

Underneath the concave cupola of the diaphragm lie the upper abdominal viscera. According to Keith (1923): "It became clear to everyone then that the viscera in the upper segment of the abdomen formed part of a respiratory piston. The upper end of the piston is covered by the diaphragm. When that muscle contracts during inspiration the upper end of the piston moves in a downward and forward direction; the piston is returned by a contraction of the muscles of the belly wall; the visceral piston is not only supported by muscles, it is delicately poised in all phases of respiration between the opposing muscular groups."

A viscus underlaying a defect in the diaphragm is unlikely to follow the downward excursions of this muscular partition. One can even conceive of it serving as a dilating wedge gradually inserting itself through this deficiency. The best evidence in support of this view is the manner in which inconspicuous injuries to the diaphragm become gaping clefts (Barrett, 1945). This is quite apart from the inequality of pressures on either side of the diaphragm in certain phases of respiration and the sharp rises in intra-abdominal pressures which occur in the day-to-day

life of the individual. In our patient the kidney appears to have functioned as such a dilating wedge. Even in utero the flexed limbs lie against the compressible abdominal wall of the fœtus. Transmitted pressures during intra-uterine life could favour transference of abdominal contents into the non-collapsible thorax in the presence of a diaphragmatic defect.

The Kidney and the 'Sliding Plane'.—The permanent kidney—the metanephros—is differentiated from the hinder end of the nephrogenic cord at segmental level corresponding to approximately sacral 1 or 2. The tissue plane in which the so-called 'ascent' of this metanephric kidney occurs is dorsal to the mesonephros, and within an area of loose mesenchyme. This loose mesenchymal zone can be traced in serial sections of the embryo cranially, to beyond the developing adrenal gland which occurs in the medial cœlomic bay between the anterior end of the mesonephros and the dorsal mesentery. This has been observed both by Fraser (1931) and by Kiebel and Mall (1912). In fact, Kiebel and Mall argue that in the embryo the developing adrenal can constitute no physical obstacle to the ascent of the kidney. It is this plane in the embryo which corresponds to the retroperitoneal and retropleural planes in postnatal anatomy. When the kidney works itself in this retroperitoneal plane through a defect in the diaphragm the anteriorly lying duodenum and the supero-medially lying adrenal will be both left behind at their usual sites. This accounts for the fact that in both this particular case and that of Barrett (1945) neither the adrenal nor the duodenum was observed in the thoracic cavity in association with the kidney.

Postnatal Growth and Retardation.—The smaller lower lobe of the right lung could very well be accounted for by the more highly placed liver and, of course, the kidney itself restraining the active postnatal growth of the lung. The enlargement of the kidney and the lengthening of the ureter may have resulted from the lack of restraining viscera round the one, and active response to stretch of the other. It is possible that the lack of development of the right lower lobe was due to interference with the development of the lung at an early intra-uterine stage by the reduction of the thoracic cavity as a result of the herniated kidney. If, on the other hand, the herniation had occurred in postnatal life it might have been expected that the affected lobe would have been atelectatic rather than hypoplasic.

SUMMARY

1. A case of congenital right-sided thoracic kidney is recorded.

2. The probable mechanics of herniation are discussed.

We would like to thank Mr. M. de S. Jayasinghe for preparation of the photographs.

BIBLIOGRAPHY

BARRETT, N. R. (1945), *Brit. J. Surg.*, **32**, 421.
CAMPANALE, R. P., and ROWLAND, R. H. (1955), *Ann. Surg.*, **142**, 176.
CRUICKSHANK, G. (1952), *Brit. J. Tuberc.*, **46**, 223.
FRASER, J. E. (1931), *Manual of Embryology*, 380. London: Baillière, Tindall & Cox.
KEITH, A. (1923), *Brit. med. J.*, **1**, 587.
KIEBEL, F., and MALL, F. P. (1912), *Manual of Embryology*, 834. Philadelphia: J. P. Lippincott.
ROBBINS, J. J., and LICH, R. (1954), *J. Urol.*, **72**, 133.
WILLIAMS, R. G., and TILLINGHAST, A. J. (1949), *Radiology*, **53**, 566.

WILMS' TUMOUR IN THE ADULT

BY K. H. SMITH

FROM THE RADCLIFFE INFIRMARY, OXFORD*

WILMS' tumour is predominantly a disease of childhood, and so far only about 105 cases have been reported in adults. This present report adds another case and reviews the literature, which is mainly American in origin. Perhaps the most comprehensive account is that of Culp and Hartman (1948), who review 97 adult cases previously reported and add 8 personal cases.

INCIDENCE

Renal tumours in adults are generally believed to be rare, and Randall (1934) considers that they form only about 2 per cent of tumours in general. In children, however, renal tumours are much more common and account for 20 per cent of all growths. Weisel, Dockerty, and Priestley (1943) reported that at the Mayo Clinic between the years 1904 and 1940 there were 44 proved cases of Wilms' tumour, but only 5 of these occurred in adults. Riches, Griffiths, and Thackray (1951) reviewed 2314 kidney tumours and found 189 (8 per cent) to be Wilms' tumours, half of which occurred in children between 2 and 4 years of age.

At the Radcliffe Infirmary, Oxford, only 7 cases of Wilms' tumour have been recorded during the years 1948–57, 6 being in children under 7 years of age, and 1 in a man aged 66 years.

The incidence of Wilms' tumour in adults is equal in the sexes, and Culp and Hartman (1948) showed from their review of 105 cases that both sides were equally affected and that the peak age incidence was as late as the sixth decade.

SYMPTOMS

All previous authors are agreed (Hill, 1946; Russell Taylor, 1950; Riches and others, 1951) that the first symptom is often the detection of a mass in the loin by the patient himself. Pain, pyrexia, progressive anæmia, loss of weight, and dyspnœa

* Present address: The General Hospital, Northampton.

due to pressure on the diaphragm are all commonly encountered (Winsbury-White, 1948). However, urinary symptoms are slight and, unlike other malignant tumours of the kidney, hæmaturia is distinctly unusual, occurring in under 20 per cent of patients (Riches and others).

PATHOLOGY

These tumours are often very large, but show little tendency to invade neighbouring viscera. There is often a tough fibrous capsule, but in rapidly growing tumours this may be incomplete; in such a case the tumour may spread into the peri-renal fat and become adherent to the posterior abdominal wall and diaphragm. Invasion of the renal pelvis and renal vein has also been noted (Russell Taylor), and in the latter event tumour emboli easily reach the lungs. Metastases are often present when the tumour is first noted, and Russell Taylor states that their common sites are in the lungs (44 per cent), liver (20 per cent), regional lymph-nodes (8 per cent), and bones (8 per cent).

Culp and Hartman emphasize the confusing nomenclature of these tumours by listing over fifty different names. They bring evidence to show the embryonal origin of these tumours from primitive multipotent cells of the renal blastema.

TREATMENT

From a study of the literature it is clear that three methods of treatment are advocated. (1) Nephrectomy only. The principal advocate of this is Ladd (1938; Ladd and White, 1941), who points out that any renal tumour, no matter how large, can be removed by transperitoneal nephrectomy. He claims that, for this reason, pre-operative X-ray therapy is unnecessary and that examination of specimens which have received pre-operative X-ray treatment always shows viable tumour cells. (2) Pre-operative X-ray therapy followed by nephrectomy. (3) X-ray therapy both before and after nephrectomy seems to be most favoured at the present time (Riches, 1954), but both the latter author and Twistington Higgins (1953) point out that in spite of heavy doses of X-rays, the rapid development of metastases is all too common. The dosage suggested by Riches is 3000 r given over a period of three weeks pre-operatively and another 5000–6000 r post-operatively.

Paterson (1958) is emphatic that a combination of surgery and radiotherapy affords the best treatment for Wilms' tumour, and remarks that the order of these events is unimportant. She advocates the use of two X-ray fields front and back to irradiate the whole abdomen from diaphragm to pelvis, giving a dose of 2500 r in five to six weeks.

It appears that the chief advantages of pre-operative radiotherapy are to reduce the size of the tumour to more manageable proportions, and by thickening the capsule and reducing the vascularity of the growth, to diminish the risks of tumour embolism and spillage by manipulation at operation.

A long delay between the first symptom and start of treatment has been noted. Livermore (1953) treated by pre-operative radiotherapy followed by nephrectomy a patient whose tumour had been present for at least three years, and Moore (1943) removed a very large tumour which was known to have been present for sixteen years, which suggests that these growths may lie dormant for very long periods.

SURVIVAL

Among the 105 cases of Wilms' tumour in adults which have been reported in the literature, long survival is most unusual. Livermore states that of all cases reported up to 1953, only 5 have survived five years or more, and only 9 cases have lived three years.

In children, easily the best results reported are those of Ladd, who had 14 5-year survivors out of 54 treated cases, and Paterson, who treated 24 cases with a crude 5-year survival rate of 50 per cent. Only one of Ladd's survivors had radiotherapy; the remaining 13 were treated by nephrectomy only.

The following patient, a young man with a rapidly growing tumour, survived only three months after operation.

CASE REPORT

R. P. S. (R.I. 254058), a 23-year-old male undergraduate, was admitted to the Radcliffe Infirmary on March 25, 1958, under the care of Mr. D. A. Abernethy.

HISTORY.—His complaint was of lassitude, backache, and loss of weight for six months. He had never had any urinary symptoms. A week prior to admission he had noticed a lump in the upper abdomen. The patient was a swimming Blue and he had engaged in vigorous training until a few days before admission to hospital.

Three years previously, while serving in Malaya, he had developed dysentery, which responded rapidly to treatment, and was then investigated for pyrexia and jaundice without definite results.

ON EXAMINATION.—He was an ill man, pale, and febrile, with temperature 99·6° F. and pulse 108/min. There was a large swelling in the right hypochondrium, with marked flaring of the right lower ribs. This appeared to be a firm, smooth enlargement of the liver. Movement of the right chest was diminished and dullness to percussion extended anteriorly to the level of the fourth interspace. No ascites was detected and no other abnormality was found on physical examination.

In view of these findings and the previous history of dysentery in Malaya, a provisional diagnosis was made of amœbic abscess of the liver. He was seen in consultation (Dr. S. C. Truelove), and further investigation was arranged.

Urine: No albumin, no sugar, no R.B.C.'s. Sterile on culture. Hæmoglobin: 13·0 g. (87 per cent). R.B.C. 4·54 per c.mm. W.B.C. 9800 per c.mm. Platelets: 672,000 per c.mm. E.S.R. 78 mm./hr. (Westergren). Radiography of chest and spine (Dr. K. Lumsden): Marked elevation of right diaphragm due presumably to hepatic enlargement. No other lesion seen. Complement-fixation test for hydatid disease: (1) Negative; (2) Doubtful positive. Liver function tests all proved to be normal.

At this stage renal disease was not considered a possibility, especially as the abdominal mass seemed to be undoubtedly due to liver enlargement. Laparotomy was therefore advised.

AT OPERATION (April 2, 1958, K. H. S.).—Under general anæsthesia—thiopentone, flaxedil, ether/air (Professor Sir R. R. Macintosh)—the abdomen was opened. A large retroperitoneal tumour was found occupying the whole right side of the abdomen. It extended high up into the chest and down to the right iliac fossa, and was adherent to the posterior abdominal wall. The liver, spleen, and left kidney were normal. A biopsy of the tumour was taken and the abdomen closed.

HISTOLOGICAL EXAMINATION (Dr. W. Aherne).—"Sections show a highly cellular and rather vascular

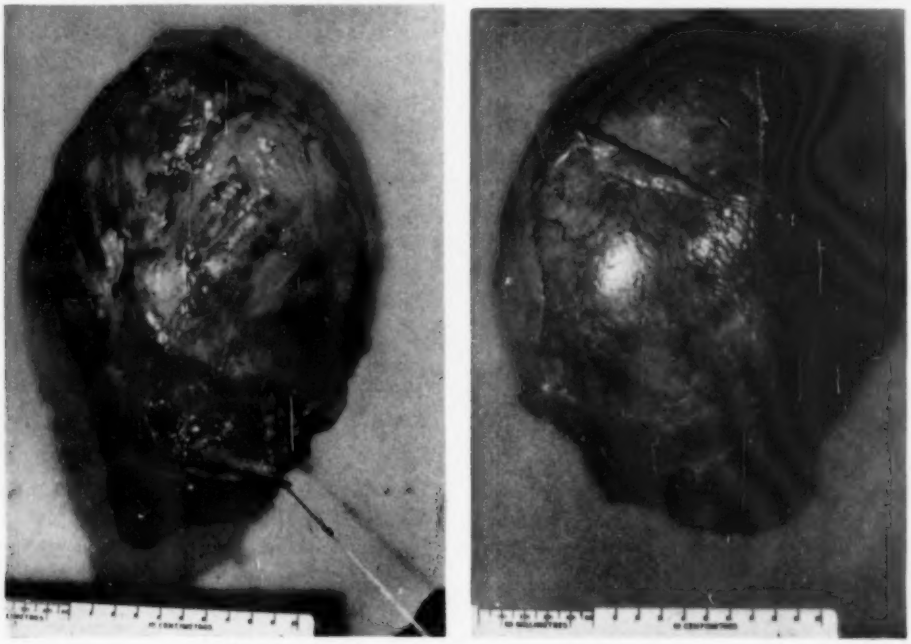
tumour. The type cell is round or spindle shaped and hyperchromatic with very little cytoplasm. Hæmorrhage has occurred from the thin-walled sinusoids which traverse the tumour. Mitoses occur infrequently. The appearances indicate a malignant tumour of mesenchymal origin. The cytology rather suggests embryonic tissue, and the presence of two primitive tubules is evidence in favour of a nephroblastoma."

The slides were sent to Dr. Martin Bodian of Great Ormond Street, who agreed with the diagnosis of nephroblastoma.

volume. Further chest radiographs still showed no evidence of secondary deposits, the blood-urea was 47 mg. per cent, and hæmoglobin 11·0 g. (75 per cent).

An intravenous pyelogram showed a normally functioning left kidney but no excretion of dye on the right side.

SECOND OPERATION.—(Right nephrectomy, July 16, 1958, K. H. S.) General anæsthesia—thiopentone, flaxedil, ether/air (Professor Sir R. R. Macintosh). The tumour was removed by the extraperitoneal lumbar route without undue difficulty and was less than half its former size.



A B

FIG. 394.—Showing A, the anterior, and B, the posterior aspects of the tumour and its capsule.

In view of these findings, the patient was seen in consultation (Dr. Frank Ellis). He felt that the best line of treatment would be to irradiate the tumour before attempting its removal.

On April 11, 1958 X-ray therapy was started and a total of 2535 r was applied to the abdomen in 25 sessions taking 34 days (250 kV. 1·3 m. Cu H.V.L.). The three-field bath technique was employed. The estimated dose to the tumour was about 3100 r.

At this stage, before radiotherapy began, the patient's general condition was very poor, and he required frequent doses of heroin to relieve pain and muscular cramps. Vomiting was frequent and severe. Further chest radiographs (April 16, 1958) showed no evidence of metastases.

By May 20, 1958, five days after the conclusion of radiotherapy, his general condition had greatly improved, and the abdominal mass was much smaller, the patient's girth having decreased from 96 cm. on April 11, 1958 to 78 cm. on May 20, 1958. He was then discharged home for a short period of convalescence before further surgery was undertaken.

On July 11, 1958 the patient was re-admitted to the Radcliffe Infirmary. He was in good general condition and the abdominal tumour was estimated to be less than half its original average diameter, i.e., one-eighth original

It appeared to be completely encapsulated, but was adherent to the undersurface of the diaphragm (*Fig.* 394). 40 mg. of radium in polythene tubes were inserted in the cavity and removed after 108 hours (Dr. F. Ellis), giving an estimated dose of 3000 r at a distance of 1 cm. outside the cavity occupied by the radium.

HISTOLOGICAL EXAMINATION (Dr. W. Aherne).—An ovoid tumour measuring 20 × 14 × 9 cm. overall. At one pole some kidney tissue was present with pelvis and a short length of ureter. The external surface of the tumour appeared generally smooth though a little lobulated. The cut surface confirmed the presence of renal tissue at one pole. Elsewhere the tumour was soft, yellowish, and rather necrotic-looking, with small scattered areas of hæmorrhage.

Sections were taken from the substance of the tumour in various places, from the capsule, from recognizable renal tissue, and from the region of the renal hilum. The bulk of the tumour was necrotic and structureless, with areas of hæmorrhage and of fibroblastic tissue in which foamy cells and hæmosiderin granules were seen. Dead tumour tissue was seen in places under the capsule. One section showed a small collection of poorly preserved tumour cells actually in the capsule. Well-preserved tumour tissue identical with that seen in the original biopsy was

present in a section taken from the upper pole of the tumour. The appearances were again those of a nephroblastoma. The capsule overlying this portion was intact. The renal tissue showed a marked degree of interstitial fibrosis, with fair preservation of glomeruli, but almost complete disappearance of tubules. Fibrosis, with evidence of old and recent hæmorrhage, was seen in relation to the renal vein; there was no tumour tissue in this situation.

Fig. 395 shows a low-power photomicrograph of the tumour, and *Fig.* 396 shows the cut surface.

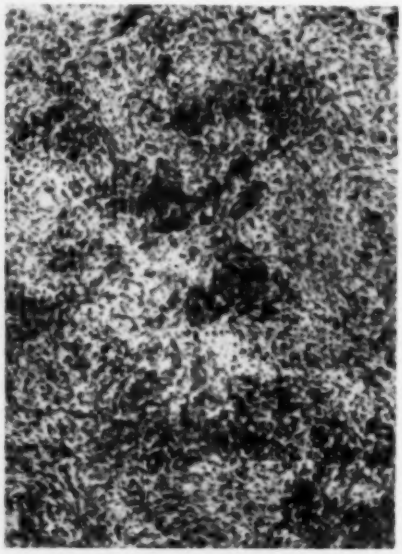


FIG. 395.—Low-power photomicrograph showing the predominant pattern of dark undifferentiated cells. (Magnification × 96.)

PROGRESS.—The patient made an excellent recovery from this operation and was discharged home on August 7, 1958.

Unfortunately, a chest radiograph taken on August 6, 1958 showed appearances in both lungs slightly suspicious of the presence of metastatic deposits, and further films (Oct. 1, 1958) showed considerable increase in the size of these deposits. The blood-urea rose steadily and on Oct. 3, 1958 was 142 mg. per cent, while the hæmoglobin level fell to 7·4 g. (50 per cent) on Sept. 30, 1958.

It was not considered desirable to give the patient any further X-ray therapy, but blood transfusions were given to correct the anæmia.

The patient was re-admitted to the Radcliffe Infirmary on Oct. 24, 1958 in very poor condition, with marked dyspnœa and a hæmoglobin level of only 4·7 g. (32 per cent). In spite of being gravely ill his morale was excellent and he had made detailed plans for his next year's activities. A further chest radiograph showed multiple metastases in the lungs and a large right pleural effusion. It was clear that the patient was moribund and he died on Oct. 26, 1958.

Permission for an autopsy was refused.

SUMMARY

The literature regarding Wilms' tumour in the adult is reviewed, 105 cases having been previously reported, mainly by American authors.

A further case is reported in which a student aged 23 years presented with a rapidly growing abdominal tumour.

After some delay in diagnosis, pre-operative radiotherapy was given, followed by nephrectomy and post-operative irradiation.

The patient succumbed three months after nephrectomy.

FIG. 396.—Showing the cut surface of the tumour with a small amount of renal tissue (arrowed).

Acknowledgements.—I am most grateful to Mr. D. A. Abernethy, under whose care this patient was admitted, for permission to treat the case and to publish this account, and also to Dr. F. Ellis for his great help and advice.

REFERENCES

CULP, O. S., and HARTMAN, F. W. (1948), *J. Urol.*, **60**, 552.
HIGGINS, T. TWISTINGTON (1953), *Modern Trends in Urology*, 150. London: Butterworth.
HILL, R. M. (1946), *Brit. J. Urol.*, **18**, 53.
LADD, W. E. (1938), *Ann. Surg.* **108**, 885.
— — and WHITE, R. R. (1941), *J. Amer. med. Ass.*, **117**, 1858.
LIVERMORE, G. R. (1953), *J. Urol.*, **70**, 141.
MOORE, T. (1943), *Brit. J. Surg.*, **30**, 381.
PATERSON, E. (1958), *J. Fac. Radiol., Lond.*, **9**, 170.
RANDALL, A. (1934), *Ann. Surg.*, **100**, 462.
RICHES, E. W. (1954), *Brit. J. Urol.*, **26**, 319.
— — GRIFFITHS I. H., and THACKRAY, A. C. (1951), *Ibid.*, **23**, 297.
TAYLOR, R. A. RUSSELL (1950), *Brit. J. Surg.*, **37**, 283.
WEISEL, W., DOCKERTY, M. B., and PRIESTLEY, J. T. (1943), *J. Urol.*, **50**, 399.
WINSBURY-WHITE, H. P. (1948), *Text-book of Genito-Urinary Surgery*, 115. Edinburgh: Livingstone.

RETROPHARYNGEAL CYST OF FOREGUT ORIGIN ASSOCIATED WITH A VERTEBRAL ABNORMALITY

By R. KENNETH RODDIE

E.N.T. DEPARTMENT, BELFAST CITY HOSPITAL, BELFAST

SINCE 1870 when von Wyss reported a case of mediastinal cyst lined with primitive œsophageal mucosa, an increasingly large number of cysts of foregut origin have been recorded in the literature under a multiplicity of names. Numerous theories have been advanced to explain the origin of these cysts, none of which have, as yet, proved universally acceptable.

Although Roth (1881) and later Staehelin-Burckhardt (1909) described a relationship between congenital mediastinal cysts and a defect of the vertebral column in their cases, it is only within recent years, especially with the increased use of radiographs in diagnosis, that the frequency of this association of cyst with a malformation of the cervical and/or thoracic vertebræ has been appreciated. Various authors, especially Veeneklaas (1952), Fallon, Gordon, and Lendrum (1954), and Rhaney and Barclay (1959), have sought to explain this finding on an embryonic developmental basis. The majority of these reported foregut cysts have been located in the superior or posterior mediastinum, and in close relationship with the tracheobronchial tree or the œsophagus.

The following case report is of interest in possessing some unusual features, notably that the cyst had definite bronchogenic characteristics and lay in direct relationship with anomalous cervical vertebræ. It would also appear to be unique in the relatively high location of the cyst.

CASE REPORT

H. W., a 30-year-old shorthand typist, attended the E.N.T. Department of a Belfast hospital on April 12, 1956, complaining of a persistently painful throat, developing about six weeks previously, following an attack of influenza. There was no dysphagia, but she had the sensation of a 'lump in the throat'. Although not subject to sore throats, she admitted, on direct questioning, to having had a 'feeling of fullness' in her throat on several occasions over the past few years. An apparently healthy and normal baby, she had had an uneventful childhood and adolescence. Menarche at 14 years of age. Removal of an ovarian cyst and appendicectomy were carried out in 1950. There was no history of tuberculosis. The family history was not contributory.

ON EXAMINATION.—She was a healthy-looking young woman. There was no external evidence of kyphosis or scoliosis. The only abnormality found in a complete systematic examination was in her throat. This was a midline retropharyngeal swelling, which displaced the posterior pharyngeal wall forwards into the lower two-thirds of the oropharynx and the upper half of the hypopharynx. The overlying pharyngeal mucosa was red and granular, but not ulcerated. On palpation the swelling was smooth, firm, regular, and immobile. Fluctuation was not elicited. It was not attached to the posterior pharyngeal wall, but appeared to be fixed to the deep structures. A hard bony-like ridge was felt at the upper limit of the swelling, just to the left of the midline. Head and neck movements were good, except that extension of the neck was slightly limited and elicited pain in the mid-cervical region.

A tentative diagnosis of chronic retropharyngeal abscess was made and the patient admitted to hospital.

INVESTIGATIONS.—A chest radiograph showed normal lung fields and cardiac outline. A radiograph of the cervical soft tissues and cervical spine (*Fig.* 397) reported "fusion of second and third cervical bodies with large bony spur projecting from the upper anterior margin of third cervical. Below this level there is marked swelling of the soft tissues, displacing the posterior pharyngeal wall forwards, and suggestive of a large retropharyngeal abscess. An old tuberculous infection of disk between second and third cervical should be excluded or the abnormality of cervical spine may be a congenital fusion similar to a Klippel-Feil."

FIG. 397.—Radiograph showing fusion of second and third cervical bodies and bony spur projecting from the upper anterior margin of C.3. Below this level there is marked swelling of the soft tissues displacing the posterior pharyngeal wall forwards.

The Wassermann and Kahn tests were negative and the erythrocyte sedimentation rate (Westergren) was 5 mm. in the first hour.

Under general anæsthesia a diagnostic aspiration of the swelling was carried out through the right posterior pharyngeal wall; 15 ml. of dark, glairy, mucoid fluid were obtained.

Bacteriological examination of this fluid was negative and no tubercle bacilli were isolated on animal culture. The biochemical examination of the fluid reported: "A few red blood-cells are present. No crystals. Insoluble in acetic acid. Soluble in alkali. Positive Biuret test. Metachromatic reaction with toluidene blue. Consistent with presence of glucoproteins."

Following this aspiration the retropharyngeal swelling was much reduced in size. During the course of the next few days no refilling of the 'cyst' occurred and the patient was symptom-free.

She was discharged from hospital on April 24, 1956, with a diagnosis of "retropharyngeal cyst of doubtful origin, possibly developmental".

During the course of the next twelve months the patient was reviewed at regular intervals. She remained well and symptom-free until January, 1957, when she again complained of the sensation of a 'lump' in her throat and a desire to swallow continuously. Examination at this stage showed that the cyst was starting to refill and by April, 1957, it had regained the size it had been twelve months previously.

The patient was admitted to Belfast City Hospital. Under general anæsthesia aspiration of the cyst was performed, again through the right posterior pharyngeal wall,

FIG. 398.—Showing extent of the cyst after injection of neohydriol.

and 17 ml. of milky, mucoid fluid were obtained. This was replaced by 5 ml. of neohydriol, and radiographs of the cervical region were taken (*Fig.* 398). The extent of the cyst, outlined with the radio-opaque medium, was now well demonstrated.

AT OPERATION (May 4, 1957).—Under general anæsthesia the cyst was approached through a left lateral vertical incision along the posterior border of the left sternocleidomastoid muscle. This muscle and the carotid sheath deep to it were retracted forwards and medially, the spinal accessory nerve having been preserved. The incision was deepened by blunt dissection to expose the floor of the left posterior triangle and the cervical prevertebral muscles. The cyst was then seen lying in the midline, in direct contact with the bodies of the third, fourth, and fifth cervical vertebræ, to which it was attached by dense fascia. Above, it was limited by a bony spur, projecting from the upper anterior margin of the body of the third cervical vertebra, the spur itself appearing to be incorporated in the cyst wall. Anterior to the cyst and displaced forwards by it, lay the constrictor muscles of pharynx and bucco-pharyngeal fascia, from which it was easily separated. Laterally it extended to the junction of the anterior roots of the transverse processes with the vertebral bodies. The approximate measurements of the cyst were $6 \times 4 \times 3$ cm. Its wall was firm and smooth.

Because of its dense fibrous connexions posteriorly with the vertebral bodies, especially the third cervical, it was not possible to free the cyst completely intact. A piecemeal removal was carried out. On opening it a considerable quantity of white, glairy, mucoid fluid and debris escaped. It appeared to be monolocular and had a smooth, pale lining membrane.

The anterior surface of the third cervical body, to which the upper pole of the cyst was firmly bound, felt deeply concave. This concavity was curetted, but no definite defect in the vertebral body was seen. The bony spur, projecting anteriorly and forming the upper limit of the cyst, was broken off from its attachment to the upper anterior margin of the third cervical body.

The wound was closed in layers with drainage.

Post-operative recovery was uneventful. When last seen in January, 1959, the patient was well and symptom-free.

HISTOLOGY (Professor J. Henry Biggart).—"The biopsy shows the presence of cystic spaces lined by a respiratory type of epithelium. The fibrous tissue wall shows an occasional structure which appears to be an arachnoid granulation, and the presence of a defect in the vertebral column should be looked for. Smooth muscle is also present in the wall. The respiratory nature of the epithelium is also confirmed by the presence of cartilage-foregut cyst."

DISCUSSION

Classification.—The classification of congenital cysts originating from the primitive gut of the early embryo has been rendered exceedingly complicated by the wide variation in terminology used to describe such cysts. In the literature these anomalies have been labelled "thoracic cysts of enteric origin", "enterogenous cysts", "bronchogenic cysts", "gastrogenic cysts", "enterocystomas", and "primary mediastinal cysts", etc.

In the majority of cases the name designated has tended to emphasize the nature of the cyst wall and the dominant type of lining epithelium present. On the whole, however, this division would appear arbitrary and only tends to confusion of usage in the literature.

In an attempt to simplify this classification various authors have suggested a more compact nomenclature. Gross, Holcomb, and Farber (1952) prefer the term "duplications of alimentary tract" and believe that all duplications and cysts have a similar origin regardless of their location. To indicate the formal genesis of these cysts from the primitive gut, Hutchinson and Thomson (1953) use the term "congenital archenteric cysts". This includes "gastrogenic", "bronchogenic", "enterogenous", and all the types of congenital cysts related to the alimentary canal.

Theories of Formation.—These cystic structures are uncommon, although the number of reviews and reports of them would tend to belie their comparative rarity. Various theories have been advanced to explain how they arise. These include the twinning theory (Edwards, 1929), the diverticulum theory (Lewis and Thyng, 1908), the vacuolation theory (Keith, 1933; Bremer, 1944), and the vitelline duct theory (Black and Benjamin, 1936). None of these concepts would explain the very frequent association of a cyst with a vertebral anomaly.

Grossly, all cysts arising from primitive foregut resemble one another, and there is no sharp line of distinction between bronchogenic cysts and those

arising from the digestive tube itself. The histology of their lining mucosa will depend on the differentiating potentialities of the cells which have become separated off from the primitive gut.

Recognition of Bronchogenic Cysts.—Fallon, Gordon, and Lendrum (1954) feel that the distinction between enteric and bronchogenic cysts can largely be made by their situation, and that site is a surer index than character of lining. They state that enteric cysts generally arise in the posterior mediastinum and have their main attachment posterior, whereas bronchogenic cysts are situated either within the lung or, more usually, in association with the main bronchi, especially on the left side. They conclude from this that true bronchogenic cysts in general arise at a later period in development, after the separation of the respiratory from the primitive intestinal system. Abell (1956) has supported this concept.

If, as sometimes happens, a bronchogenic cyst is found to have little or no connexion with the tracheobronchial tree or contains components of the digestive tract as well as respiratory elements, as in the case described by Smith (1930), it would suggest that the development of a cyst had begun at an earlier stage of embryogenesis, before separation and differentiation of the respiratory tract from the primitive foregut. It is possible for a disturbance in this area to originate before the differentiation of the œsophagus and the lung bud. A cyst arising in such a disturbed area of development might possess either the features of the œsophagus or of the respiratory system, or both.

It would thus appear possible for a cyst of primitive foregut with bronchogenic characteristics to be found in close association with the œsophagus or even vertebral bodies, if it arises early in embryogenesis. The cyst reported here would support this, as it showed definite bronchogenic characteristics, in that it was lined by a respiratory type of epithelium and contained cartilage in its wall, and it lay in direct relationship with the anomalous cervical vertebræ.

Two cases have been reported in the literature (Tucker, 1946; Maier, 1948) where the mediastinal cyst was considered to be bronchogenic in nature, and in which there was a concomitant anomaly of the cervico-dorsal vertebræ. Microscopical examination of the cyst wall in each of these cases showed all the component structures of a bronchial wall except cartilage. A further case has been recorded (Bracher and Koontz, 1952) in which a bronchogenic cyst of the posterior mediastinum was associated with a Klippel-Feil syndrome. Cartilage was absent from the wall of this cyst also. Although Fallon and others (1954) point out that the absence of cartilage in the wall does not exclude a lung-bud origin, whereas its presence would show quite definitely that such cysts were not of enteric type, they did not feel, however, that the cysts described by Tucker and Maier were, in fact, bronchogenic. They contend that of all the fully accepted bronchogenic cysts described in the literature, in none was there any record of an associated vertebral abnormality. There would seem to be no doubt, however, that the foregut cyst described here was bronchogenic in nature and was intimately related to the cervical spine anomaly. It is noteworthy that, in this case, the relationship between the cyst and vertebræ and the vertebral abnormality itself was in some respects similar to Fallon and others' first case, where the cyst was of enteric type and was attached by dense fibrous connexions to anomalous cervical bodies.

Several examples of the bronchogenic type of foregut cyst in unusual locations have been recorded (Joel, 1890; Nossen, 1925; Seybold and Claggett, 1945; Park and Buford, 1955). A review of the literature has not, however, revealed any record of a foregut cyst presenting in the retropharynx.

Concomitant Anomalies of Vertebræ.—A considerable number of cases of foregut cyst have been reported where a concomitant anomaly of vertebræ was also present (Olenik and Tandatnick, 1946; Gross, Neuhauser, and Longino, 1950; Dohn and Povlsen, 1951; Knipers and Wieberdink, 1953; Hutchinson and Thomson, 1953). This association of intrathoracic cyst with a vertebral anomaly has usually been considered to be an incidental and unrelated finding (Ehler and Atwell, 1948). Indeed, when reviewing the literature Veeneklaas (1952) noted that in some of the cases of foregut cyst the radiographs showed vertebral anomalies which were not commented on by the authors (Poncher and Milles, 1933; Davidson and Brown, 1947).

Within recent years, however, various authors have emphasized the importance and significance of this association of the cyst with a vertebral anomaly. Olken (1944) states that of all congenital anomalies occurring together with foregut cysts, developmental anomalies of the vertebræ, especially the cervical and upper thoracic, were seen most frequently. As Veeneklass (1952) points out, it is hardly probable that a congenital vertebral anomaly of such frequency would be of no importance whatsoever in the development of another congenital anomaly—the intrathoracic foregut cyst.

Developmental Basis of Associated Vertebral Anomalies.—To seek an explanation of this combination of congenital anomalies, attention has been focused on the complex developmental processes occurring in the hinder head region of the embryo during the third week.

At this stage of development a very close relationship exists between the notochordal rod and the entodermal tube. The notochord, the forerunner of the spinal column, is being formed by an ingrowth of ectoderm from Henson's node in the anterior lip of the primitive streak. As this notochordal plate of cells lengthens it sinks into the entoderm and becomes incorporated for a short time in the roof of the archenteron. Presently it is extruded from the entoderm and, moving dorsally, forms the notochordal rod between entodermal tube and neuroectoderm.

It was Veeneklaas (Veeneklaas, van Zeben, Reerink, and Tegelaers, 1951; Veeneklaas, 1952) who first postulated the idea that the primary disturbance in genesis of these cysts must be looked for, not in a developmental anomaly of foregut, but in an accident involving spine and foregut together, at a time when these cells still adhere to each other. He suggested that for some, as yet, unexplained reason the normal process by which the notochordal cells are excalated from the entoderm does not occur. The notochord and primitive foregut thus fail to separate and, in the area where the connexion remains,

cysts or diverticula of the foregut may develop. The statement by Patten (1946) that "fusions of notochord at its cephalic end . . . with pharyngeal epithelium are not uncommon occurrences" would substantiate this concept of formation. Fallon and others (1954) maintain that separation of the notochord from the primitive gut must be complete if the subsequent investment of the notochord by the mesoderm anlage of vertebral column is to proceed in a normal fashion.

The foregut cyst described in this case report, with bronchogenic characteristics, and associated with the anomaly in segmentation at the cephalic end of the notochord, would support this notochordal theory of origin. The developmental disturbance in this case probably occurred very early in embryogenesis, before the differentiation of œsophagus and lung bud.

An extension of this notochordal theory (Rhaney and Barclay, 1959) and the knowledge of the close anatomical proximity of the neuroectoderm and entodermal tube in early embryo may serve as an explanation for the presence of structures resembling arachnoid granulations in the fibrous tissue wall of the cyst.

At the time the notochord is beginning to form, a small hole, the neurenteric canal, communicates for a short time between the amniotic cavity and the yolk cavity at the anterior end of the primitive streak. With its formation the entoderm lining the archenteron becomes continuous with the neuroectoderm on the dorsal surface of the embryonic plate. It normally closes late in the fourth week.

Bremer (1944, 1952) draws a distinction between this short-lasting neurenteric canal and any patent or solid tract which may occur between the alimentary tract and the dorsal midline structures cephalad to the coccygeal tip. He states that this latter condition represents an ectopic or accessory neurenteric canal because the primitive node is not traversed.

Saunders (Saunders, 1943; McLetchie, Purves, and Saunders, 1954) maintains that these neurenteric connexions may occur at any level and are apparently caused by adhesions between the developing entodermal tube and the neuroectoderm itself. He suggests that all primitive cysts and diverticula are caused by traction on a neurenteric adhesion, and that the majority lose their connexion with the central nervous system through a process of "attenuation and obliteration" as the axial structures move farther apart.

Rhaney and Barclay (1959) point out that these adhesions between entodermal tube and neuroectoderm presumably lie in the central axis of the embryo and must therefore traverse a cleft in the notochord. They suggest that the cleft or split in the notochordal rod can be explained by the theory that the notochord is formed from two lateral streams of cells which converge through Henson's node and unite on its cephalic side (Dodds, 1941). If an ento-ectodermal ahdesion persists too long it would prevent fusion of the converging notochordal streams. This could result in defective fusion of the sclerotomes and give rise to subsequent vertebral abnormality. They quote several cases reported in the literature (Guillery, 1937; Lawson, 1953; Holcomb and Watson, 1954) where there was definite evidence of a connexion between an intrathoracic cyst and the spinal cord through defective vertebral bodies. The fact that in Guillery's case there was no true gap in the anomalous vertebral body has led Fallon and others (1954) to the conclusion that almost completely normal vertebræ may eventually be formed, despite the presence in early development of an ento-ectodermal adhesion, and, as Veeneklaas (1952) points out, tomography is often required to demonstrate the defect in vertebral bodies and arches.

The vertebral anomaly in the case reported here consisted of a fusion of the second and third cervical bodies, and hollowing out of the anterior surface of the third cervical body, with a bony spur projecting forwards from its upper anterior margin. There was no evidence of an anterior defect of the spinal canal with herniation of the meninges through it. However, if one accepts the notochordal theory of origin, and the concept of neurenteric adhesions occurring between the developing entodermal tube and the neuroectoderm itself, through a cleft or split in the notochord, the inclusion of neural tissue in the wall of the cyst could be explained.

It is interesting to speculate on whether the bony spur present in this case could possibly have been formed in a somewhat similar fashion to the median bony spur projecting into the spinal canal in the condition known as diastematomyelia, where, according to Holcomb and Watson (1954), it is evidence of the former presence of a dorsal neurenteric fistula passing through all the dorsal midline structures.

It is uncommon to find the cyst lying in contact with the abnormal vertebræ, as occurred in this case. As a rule it tends to move caudally with the growth of intrathoracic viscera. Here, however, such traction was obviously not a factor. The usual separation of the cyst from its site of origin may explain why the cervico-dorsal vertebral lesion is often missed, or if seen is not correlated with the cyst.

The Clinical and Diagnostic Problem.—Clinically the case reported here presented a problem in diagnosis. When the patient was first seen a tentative diagnosis of a retropharyngeal abscess was made. The possibility of this being tuberculous in nature and associated with a cervical caries was considered. Nothing, however, was found to substantiate this diagnosis.

A non-specific inflammatory condition of retropharyngeal lymph-nodes was also eliminated, following a diagnostic aspiration of the swelling. Its cystic nature was now obvious and was well demonstrated on radiography following the injection into it of a radio-opaque medium.

Although the possibility of the cyst being developmental in origin was considered, its true nature, i.e., a cyst of the primitive foregut, was not ascertained until operation and histological examination of the material removed.

The comparatively sudden onset of symptoms that occurred in this patient probably resulted from minor alterations in the blood-supply of the cyst, leading to an increase in its content, either as a result of increased production of mucus or as a result of transudation from its lining. Further, in contradistinction to foregut cysts of the gastro-enterogenous type where symptoms develop in early childhood, those with bronchogenic characteristics usually do not give rise to symptoms, or are not discovered until

adult life. Abell (1956) feels that this does not in any way detract from the developmental hypothesis. He stresses that their growth is slow and that symptomless cysts of this type have been observed for years with very little increase in size.

The possibility of this cyst being a teratoma or an epignathus can be excluded in view of the absence of multiple tissues usually present in these highly organized structures.

Finally, it was considered whether this cyst could have a branchiogenic origin. Cysts arising from the branchial elements would lie too far lateral and anterior to cause confusion with the cyst in this case, which was midline. It would also be extremely difficult to explain the presence of smooth muscle-fibres in the wall of the cyst if it was of branchial origin, although the cartilage would not present the same difficulty. There were no aggregates of lymphoid tissue present such as are sometimes found in branchial cysts, nor were there any elements that would be expected if the cyst had originated from the lower pouches.

SUMMARY

1. The successful removal of a cyst of the primitive foregut, arising in the retropharynx and associated with an abnormality of the cervical vertebræ, is recorded.

2. The cyst had definite bronchogenic characteristics and would appear to be unique in its relatively high situation. It is suggested that the developmental disturbance occurred very early in embryogenesis, before differentiation of the œsophagus and lung bud.

3. This case supports the theory that foregut cysts arise as a result of abnormal connexions between the axial body structures in early embryonic life, and that these disturbances are associated with, or result from, splitting of the notochordal rod, which gives rise to the vertebral abnormality.

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REFERENCES

ABELL, M. E. (1956), *Arch. Path. (Lab. Med.)*, **61**, 360.
BLACK, R. A., and BENJAMIN, E. L. (1936), *Amer. J. Dis. Child.*, **51**, 1126.
BRACHER, A. N., and KOONTZ, A. R. (1952), *J. Amer. med. Ass.*, **150**, 1006.
BREMER, J. L. (1944), *Arch. Path. (Lab. Med.)*, **38**, 132.
— — (1952), *Ibid.*, **54**, 132.
DAVIDSON, L. R., and BROWN, L. (1947), *J. thorac. Surg.*, **16**, 458.
DODDS, G. S. (1941), *Amer. J. Path.*, **17**, 861.
DOHN, K., and POVLSEN, O. (1951), *Acta chir. scand.*, **102**, 21.
EDWARDS, H. (1929), *Brit. J. Surg.*, **17**, 7.
EHLER, A. A., and ATWELL, S. (1948), *J. thorac. Surg.*, **17**, 809.
FALLON, M., GORDON, A. R. G., and LENDRUM, A. C. (1954), *Brit. J. Surg.*, **41**, 520.
GROSS, R. E., HOLCOMB, G. W., and FARBER, S. (1952), *Pediatrics*, **9**, 449.
— — NEUHAUSER, E. B. D., and LONGINO, L. A. (1950), *Ann. Surg.*, **131**, 363.
GUILLERY, H. (1937), *Zbl. allg. Path. path. Anat.*, **69**, 46.
HOLCOMB, G. W., and WATSON, D. D. (1954), *Surgery*, **35**, 115.
HUTCHINSON, J., and THOMSON, J. D. (1953), *Brit. J. Surg.*, **41**, 15.
JOEL, J. (1890), *Virchows Arch.*, **122**, 381.
KEITH, A. (1933), *Human Embryology and Morphology*. Baltimore: Wood.
KNIPERS, F., and WIEBERDINK, J. (1953), *J. Pediat.*, **42**, 603.
LAWSON, F. L. (1953), *J. Amer. med. Ass.*, **151**, 271.
LEWIS, F. T., and THYNG, F. W. (1908), *Amer. J. Anat.*, **7**, 505.
MCLETCHIE, N. G. B., PURVES, J. K., and SAUNDERS, R. L. de C. H. (1954), *Surg. Gynec. Obstet.*, **99**, 135.
MAIER, H. C. (1948), *Ann. Surg.*, **127**, 476.
NOSSEN, H. (1925), *Dtsch. med. Wschr.*, **51**, 1150.
OLENIK, J. L., and TANDATNICK, J. W. (1946), *Amer. J. Dis. Child.*, **71**, 466.
OLKEN, H. G. (1944), *Amer. J. Path.*, **20**, 997.
PARK, O. K., and BUFORD, C. H. (1955), *Ann. Surg.*, **142**, 130.
PATTEN, B. M. (1946), *Anat. Rec.*, **95**, 307.
PONCHER, H. G., and MILLES, G. (1933), *Amer. J. Dis. Child.*, **45**, 1064.
RHANEY, K., and BARCLAY, G. P. T. (1959), *J. Path. Bact.*, **77**, 457.
ROTH, M. (1881), *Virchows Arch.*, **84**, 371.
SAUNDERS, R. L. de C. H. (1943), *Anat. Rec.*, **87**, 255.
SEYBOLD, W. B., and CLAGGETT, O. T. (1945), *J. thorac. Surg.*, **14**, 217.
SMITH, R. E. (1930), *Guy's Hosp. Rep.*, **80**, 466.
STAEHELIN-BURCKHARDT, A. (1909), quoted by OLKEN (1944).
TUCKER, G. (1946), *Ann. Otol., etc., St. Louis*, **55**, 693.
VAN DER HAL, I., and MOOY, G. S. F. (1950), quoted by FALLON and others (1954).
VEENEKLAAS, G. M. H. (1952), *Amer. J. Dis. Child.*, **83**, 500.
— — VAN ZEBEN, W., REERINK, H., and TEGELAERS, W. H. H. (1951), quoted by KNIPERS and WIEBERDINK (1953).
VON WYSS, H. (1870), *Virchows Arch.*, **51**, 143.

GUSTATORY SWEATING AND PILOMOTOR CHANGES

By W. B. ASHBY

FORMERLY SURGICAL REGISTRAR, DAVID LEWIS NORTHERN HOSPITAL, LIVERPOOL

INTRODUCTION

ABNORMAL localized sweating associated with eating—so-called gustatory sweating—may occur in a variety of circumstances.

It is well recognized that gustatory sweating of half the face may follow operations on the cervico-dorsal sympathetic chain, particularly cervico-dorsal sympathectomy (Haxton, 1948). The anomaly has also been reported in syringomyelia (Souques, 1927; Wilson, 1936), after operations on the nose (André-Thomas and Bars, 1927), or associated with congenital defects (Uttl, 1932).

Under the heading "Le syndrome du nerf auriculo-temporal", Frey in 1923 reviewed earlier reports and described the syndrome characterized by unilateral erythema and sweating of an area of skin of the cheek and temple associated with eating. Frey's syndrome is the best known type of abnormal gustatory sweating and is seen as a delayed complication of suppurative parotitis that has required surgical drainage. It may also follow injury or operation in the parotid region.

Apparently related is the unilateral gustatory sweating of the submental and lower lip skin that Uprus, Gaylor, and Carmichael (1934) described after operation on the side of the neck.

Haxton (1948) reported gustatory hyperidrosis of half the face in 9 out of 24 patients following upper thoracic sympathectomy (Telford operation), and in 4 out of 12 patients after cervico-thoracic sympathectomy. The two cases presented here both exemplify this condition and are unusual in two respects:—

1. The sweating in addition involves parts of the upper limb. One of Haxton's patients complained of sweating of the forearm, cubital fossa, and palm in addition to the face, and although the sweating was not observed clinically, electrical conductivity tests of the skin supported the patient's story.

2. In addition to sweating on eating both patients developed areas of goose-flesh. "Gustatory goose-skin" in addition to sweating was observed by Herxheimer (1958) and his record appears to be the first in the literature. Herxheimer's patient developed the condition after injury to the sympathetic chain in the course of a thoracoplasty.

Because of the unusual distribution and nature of the gustatory response, these patients have afforded particular opportunities to investigate the problem of gustatory sweating. It is my intention here to make what deductions can be made from their investigation and to correlate them with related auriculo-temporal and submental syndromes.

METHODS

The response to different oral stimuli was studied and tested to see if the effect could be blocked or modified at the effector cell by atropine or at the autonomic ganglion by pentolinium (ansolysin) or stellate ganglion block with local anæsthetic.

Different oral stimuli were chosen:—

1. To discover whether the response varied in kind as well as in degree to different stimuli.

2. To find a convenient and reliable way of provoking the response under study.

The response included vascular changes, pilomotor changes (goose-flesh), and sweating. It has been claimed that the gustatory sweating is explained in whole or in part by hypersensitivity of the sweat-glands (after damage to their nerve-supply) to their transmitter chemical acetylcholine. Acetylcholine was administered intravenously in these patients in an attempt to induce the phenomenon and to determine to what extent the sweat-glands were hypersensitive.

The return of sympathetic functions (sweating and goose-flesh) to the sympathectomized region with gustatory stimuli suggested testing the response to thermal stimuli, and this was done by warming the patient for about half an hour under heat cradles.

Sweating was made evident for the photographs by dusting with quinizarin powder. When wet, quinizarin powder changes from dusty blue to a bright violet colour.

CASE REPORTS

Case 1.—J. L. H., a man of 35 years, complained in February, 1957, of gustatory sweating on the left side of the face and left forearm stump for five years.

The condition developed gradually six months after left cervico-dorsal sympathectomy, performed to improve the skin circulation in his stump. He also complained of coldness of his amputation stump and lower half of that arm for a few months. The amputation was 6½ in. below the olecranon and had been for Volkmann's contracture, complicating the treatment of a war injury to his hand. The cervico-dorsal chain had been resected from the third thoracic ganglion to the neck of the first rib. The patient claimed that after operation the doctors had noticed slight drooping of his left eyelid, but he had not noticed this himself and it now needed careful examination to detect the slight ptosis and myosis on the left side. Six months after operation he noticed that when he ate sauces, pickles, or vinegary foods he was subject to a prickly sensation in the left side of the face, neck, shoulder, arm, and forearm stump. The sensation came on as he "took the first bite" and was followed "within seconds" by sweating of the same area. The severity of the attacks developed gradually but had not progressed recently. The reaction only occurred with spicy foods (to which he was particularly partial) and was accentuated if served with a hot meal.

On examination, the skin and the forearm stump had a magenta tint and below midarm level the skin was colder to touch than the other side. The brachial pulses were equal and there was no motor weakness or sensory change.

EFFECT OF HEATING PATIENT.—*Fig.* 399 shows the sweat distribution after warming the patient under heat cradles (thermal sweating). There was sweating of the whole body except the left side of the face, neck, and upper limb (sympathectomized side) which remained dry.

EFFECT OF GUSTATORY STIMULI.—1. Piccalilli served with a cold meal or a hot meal of strong curry led to the same response. Twenty seconds after beginning the meal the patient experienced a tingling sensation in the left side of the face and goose-flesh sensation and appearance of the left arm and forearm stump. There was erythema of the left forehead. Beads of sweat became visible after 60 seconds,

FIG. 399.—*Case* 1. Thermal sweating. Patient has been heated under a heat cradle and sweat made evident by sprinkling quinizarin powder. The left side of the face and upper limb (side of previous sympathectomy) remain dry.

and *Fig.* 400 shows the distribution on the left forehead, cheek, and distal part of the stump. If the piccalilli was served with a hot meal the sweating on the left side of the face was profuse, and *Fig.* 401 shows that there was, in addition, sweating of the right side of the face. The sweating on the right side was interpreted as physiological

2. Chewing pledgets of gauze soaked in 5 per cent acetic acid or sucking citric acid crystals led to a response similar in effect and distribution to that caused by piccalilli served in a cold meal. The response was slower to appear (60 seconds for tingling and goose-flesh and 2 minutes for sweating) and less marked. There was no obvious erythema of the forehead.

EFFECT OF INTRAVENOUS ACETYLCHOLINE.—Ten mg. of acetylcholine in 1 ml. of water was injected slowly intravenously. Two difficulties were encountered. The first was due to the rapid destruction of acetycholine in the body, so that the effects varied more with the rate of injection than with the total dose. The other difficulty was an apparent difference in the pharmacological action of solutions of acetylcholine obtained from different sources. This variation was attributed to acetylcholine keeping poorly in solution, so later on the solution was made up freshly from powder immediately before use. At first a solution marketed in ampoules was used, but only four ampoules of this preparation were available and they were old stock from the dispensary and the manufacturers have since ceased to market acetylcholine. During the injection the patient experienced a feeling of constriction in the chest and tingling of the left side of the face. The first beads of sweat appeared on the left side of the face. Both sides appeared to sweat equally, but it took a little longer to dry on the left forehead. Acetylcholine solutions from ampoules made by another firm of manufacturing chemists, and acetylcholine prepared freshly from the powder, were then used. Both had the same effects, which differed from those of the first ampoules in that they produced a frontal headache rather

FIG. 400.—*Case* 1. Gustatory sweating. Patient has been given piccalilli in a cold meal. Photograph shows sweating of left side of face and forearm stump.

FIG. 401.—*Case* 1. Gustatory sweating. Patient photographed after eating piccalilli served in a hot meal. In addition to sweating of the left side of the face and forearm stump there is 'physiological' gustatory sweating of the right side of the face.

than a feeling of constriction in the chest. There was no tingling sensation on the left side of the face and the sweating was symmetrical and equal. With each preparation the dose and the rate of injection was varied to give rise to minimal sweating, but in no case was it found possible to produce sweating on one side of the face that differed substantially from that on the other, i.e., the sweating response to eating could not be mimicked by administering acetylcholine intravenously.

EFFECT OF LEFT STELLATE GANGLION BLOCK.—Stellate ganglion block on the sympathectomized side by the anterior approach, using 5 ml. of 2 per cent xylocaine, led to a full Horner's syndrome in 13 minutes and completely abolished the gustatory syndrome tested with piccalilli until the Horner's syndrome began to wear off after 1¾ hours. There was no increase in skin temperature of the stump, which remained at 26·2° C. compared with 32·5° C. at a corresponding site on the other forearm.

EFFECT OF INTRAVENOUS ATROPINE.—After gr. $\frac{1}{50}$ atropine, sweating but not the goose-flesh response was abolished after gustatory stimuli.

EFFECT OF INTRAVENOUS PENTOLINIUM.—The entire gustatory phenomenon was abolished by the injection of 5 mg. pentolinium.

Case 2.—G. B., a married woman aged 43 years, complained in April, 1957, of gustatory sweating of the right side of the face and arm. The trouble started nine months after right cervico-dorsal sympathectomy for

FIG. 402.—*Case* 2. Thermal sweating. The right side (side of previous sympathectomy) remains dry after heating patient under a heat cradle.

Raynaud's syndrome complicating cervical rib. The operation had been the same as in *Case* 1, namely, resection of the sympathetic chain and ganglia from the level of the third rib to the neck of the first rib; half of the stellate ganglion had been removed. The patient stated that she dreaded meal times, for with each meal she would perspire, and if she wore long-sleeved dresses the sweating of the right arm would cause dye from the sleeve to stain her arm. In short sleeves, as soon as the meal began she would be embarrassed by having to start "mopping-up operations" on her arm and neck. The Raynaud's syndrome had temporarily been cured on the right and worst side by the operation, but had gradually relapsed as the gustatory sweating made its appearance. During meals she also developed goose-flesh of the right arm and she claimed that the blueness and coldness of the fingers of the right hand were worse at meal times. She had not associated the attacks with particular flavours and said that they came on to some extent with any food, including chocolate. Brown-Sequard (1850) personally experienced sweating of the upper lip on eating chocolate. The sweating was more marked with hot meals and meals she particularly enjoyed.

There was a mild right Horner's syndrome, but considerably less than it had been immediately after sympathectomy. The right hand and fingers were slightly mauve-coloured and colder than the left. There were no motor or sensory disturbances in the limb. Pulse was normal and not significantly altered by bracing, elevating, or depressing the shoulder girdle. Palpation of the neck revealed a bilateral buttress type of cervical rib.

EFFECT OF WARMING PATIENT.—Under a heat cradle the side of the face, neck, and upper limb on the right (sympathectomized) side remained dry while the rest of the body sweated (*Fig.* 402).

EFFECT OF GUSTATORY STIMULI.—With a hot meal the right arm became goose-pimpled from the shoulder to the wrist in 20–30 seconds, and with sweating of the right side of the face, supraclavicular triangle, and cubital

FIG. 403.—*Case* 2. Gustatory sweating. Sweating of right side of face and cubital fossa after eating a hot meal.

fossa (*Fig.* 403) in 2–3 minutes, colour changes and coldness of the hand were accentuated. This reaction was also reproduced to a lesser degree after chewing gauze soaked in 5 per cent acetic acid or eating curry. It must be admitted that the sweating observed was neither of the degree nor extent described by the patient. She was a reliable witness and probably the explanation was that the maximal response was excited by food she particularly enjoyed in congenial surroundings. The particular effect of food the patient enjoys has been noted in other patients with gustatory sweating (Payne, 1940).

EFFECT OF INTRAVENOUS ACETYLCHOLINE.—Five mg. acetylcholine given slowly produced a symmetrical response with erythema and sweating on both sides of the body.

EFFECT OF RIGHT STELLATE GANGLION BLOCK.—Right stellate ganglion block (anterior approach using 5 ml. of 2 per cent xylocaine) returned the colour of the right hand to normal and reversed the temperature difference between the hands, making the right warmer than the left. The gustatory response in the right side of the face and the right arm was abolished completely for 1½ hours.

EFFECT OF COMPLETE EXCISION OF STELLATE GANGLION.—A second exploration of the neck was undertaken on Feb. 17, 1958, and the remaining upper half of the right stellate ganglion excised. The operation abolished the gustatory sweating and goose-flesh, was followed by a complete right Horner's syndrome, and improved the skin temperature of the right upper limb so that it was again warmer than the left. The result has persisted eight months to the time of writing.

DISCUSSION

Two cases have been described of unilateral facial gustatory sweating developing six and nine months respectively after, and on the side of, cervico-dorsal sympathectomy. In both patients parts of the upper limb on the affected side became goose-pimpled and sweated with the face, and there was also some return of vasomotor tone in the sympathectomized upper limb. If there was any return of thermal sweating it was insufficient to be detected by quinizarin powder.

There seemed to be two possible explanations for the return of sweating (gustatory) in the sympathectomized skin areas. Either the denervated sweat-glands develop an increased sensitivity to the normal transmitter substance, acetylcholine, reaching them indirectly through an intact reflex, or else there is regeneration of a nervous reflex arc innervating them directly. The first possibility has been discarded because:—

1. Intravenous acetylcholine led to symmetrical sweating and did not reproduce the syndrome as manifested clinically. The dose and rate of injection were varied, but on all occasions when sweating occurred, the extent and distribution was similar on both sides.

2. In the purely facial gustatory sweating syndromes it has been suggested (Langenskiold, 1946) that acetylcholine liberated from salivary glands was diffusing to and acting on nearby hypersensitive sweat-glands. It is difficult to apply this explanation in these two patients in whom sweating of the arm appeared simultaneously with that on the face.

3. The skin of the sympathectomized arm became 'goose-flesh' in about 20–30 seconds after gustatory stimuli in addition to sweating. Goose-flesh is caused by contraction of the pilomotor muscles in the skin supplied by adrenergic endings. If the gustatory sweating is to be accounted for by an increased sensitivity of the sweat-glands to acetylcholine which is released into the circulation only with eating, it does not explain the goose-flesh effect in the arm with eating.

In favour of the phenomena being due to regeneration of nerve-fibres are the following observations:—

1. Stellate ganglion block on the affected and previously sympathectomized side in both cases abolished the gustatory response for the effective period of action of the local anæsthetic. In *Case* 2, in addition, it improved the deteriorated skin circulation of the arm to what it had been immediately after sympathectomy.

2. In the second patient excision of the remaining upper half of the stellate ganglion completely abolished the gustatory phenomena and improved the circulation of the upper limb on that side.

3. The latent interval of 6–9 months between sympathectomy and the development of the syndrome corresponds with the time of relapse Simmons and Sheehan (1937) found after cervical sympathectomy. These authors, working on clinical material from Professor Telford's clinic, were investigating late relapses after cervical sympathectomy for Raynaud's disease. They were able to demonstrate the return of function in sudomotor nerve-fibres of the ulnar nerve in relapsed patients, and concluded that disappointment in the late results from cervical sympathectomy was due to regeneration of sympathetic fibres.

Dale (1935) has suggested that pre-ganglionic (cholinergic) fibres may sometimes regenerate along post-ganglionic cholinergic pathways. As sweat-glands have a cholinergic nerve-supply, this type of regeneration was considered but rejected because suppression of the response by pentolinium (a ganglion-blocking agent) indicated the presence of a ganglion in the pathway. It is difficult to explain why the response in a regenerated reflex should be more than in the original reflex (contralateral side as control) unless fibres originally destined to structures other than sweat-glands are now redirected to sudomotor and pilomotor endings. Because the abnormal reflex is gustatory, one would expect the intended destination of the impulses to be to a related structure, probably the salivary glands. It is frequently claimed that sweat-glands in the area of gustatory sweating are 'hypersentitive' to acetylcholine (Wilson, 1936; Haxton, 1948). Although it could not be demonstrated in our particular patients, it is true that often in response to cholinergic drugs the affected area displays earlier and more profuse sweating than the skin of the rest of the body (acetylcholine—Langenskiold, 1946; mecholine—Wilson, 1936; pilocarpine—Haxton, 1948). This is exactly what one would expect if the gustatory sweating is due to an abnormal reflex that has formed as the result of faulty regeneration.

The apparent hypersensitivity to cholinergic drugs may not be due to hypersensitivity of the sweat-glands, but to summation by acetylcholine of heightened, yet still sublimal, reflex nervous activity (i.e., the sweat-glands in the area of gustatory sweating may be nearly sweating before they are additionally stimulated by cholinergic drugs).

The most interesting problem presented by these patients is why there should be a return of sudomotor, vasomotor, and pilomotor activity in the sympathectomized skin as a gustatory reflex, without corresponding return of activity as a thermal reflex. If one reflex regenerates without the other we must presume that they are served by different pre-ganglionic fibres. It is reasonable to suppose that pre-ganglionic fibres concerned in the gustatory mechanism supplying vasomotor salivary fibres and sweat-glands run in different white rami from fibres

concerned in the temperature-regulating mechanisms that innervate blood-vessels and sweat-glands. Until more is known of the functional components and distribution of fibres in the white rami of the upper thoracic nerves, we can only speculate.

Classically, nerve-fibres regenerate by growth of neurofibrils from the proximal cut end growing down Schwann tubes of the distal cut end. It is now accepted that another type of regeneration may occur in which neurofibrils originate by sprouting of *intact* nerve-fibres, and Murray and Thompson (1957), in a recent contribution, have demonstrated this form of regeneration in the autonomic nervous system. As Haxton (1948) points out, hemifacial gustatory sweating is not an uncommon sequel of upper limb sympathectomy. In Haxton's case, as in the present cases, the reflex was broken by stellate ganglion block, indicating that the origin of the regenerating fibres is at the root of the neck or below. This new conception of nerve regeneration by sprouting from intact nerve-fibres makes one wonder if it is safe to leave half or more of the stellate ganglion and the white ramus of the first thoracic nerve (the intention being to spare the patient a Horner's syndrome) in the usual cervico-dorsal sympathectomy of to-day. On the other hand, in the experience of Ross (1953), "post-operative gustatory sweating is manifested mostly in the patients who show least evidence of persistent sympathetic activity after operation". Perhaps it is that if all the lines, as it were, are engaged by fibres concerned in gustatory reflexes, the subscribers are protected from the more serious consequences of calls from thermo-regulatory sources.

The link between gustatory sweating following sympathectomy, Frey's syndrome, and the submental sweating syndrome may be that each represents a faulty regeneration whereby nerve-fibres supplying other structures become misdirected to supply sweat-glands. In these two cases the faulty regeneration has been at pre-ganglionic level, as witness goose-flesh or adrenergic pilomotor activity as part of the gustatory responses. In auriculo-temporal and submental sweating syndromes, the regeneration is at post-ganglionic sudomotor fibre level. Ford (1953) suggests a crossed regeneration between cholinergic salivary fibres and sweat fibres in the auriculo-temporal nerve in Frey's syndrome, and Uprus, Gaylor, and Carmichael (1934) offer a similar explanation for the submental sweating syndrome.

An interesting observation lending support to the explanation of crossed regeneration of neurones as the cause of Frey's syndrome is that of Glaisser, Hearnshaw, Heffron, Peck, and Patey (1958). They demonstrated that heating a patient suffering from Frey's syndrome led to increased parotid secretion on the side of the syndrome while sweating in that temple was less than on the other side; evidently some of the auriculo-temporal sudomotor nerves were now innervating the parotid.

Another very interesting example of this crossed re-innervation phenomenon is to be found in the rare cases of 'crocodile tears' or gustatory lacrimation reported by Ford (1953) after lesions of the facial nerve. (Tears are supposed to fill the eyes of crocodiles as they eat their victims.)

SUMMARY

1. Two cases are described of unilateral sweating of the face and goose-flesh and sweating of parts of the upper limb with eating.

2. The condition appeared 6 and 9 months respectively after cervico-dorsal sympathectomy.

3. In both cases the skin of the sympathectomized face and arm perspired with eating, but remained dry with heating.

4. In both patients the effect was abolished by a ganglion-blocking drug and by stellate ganglion block with local anæsthetic. In one patient it was abolished permanently by excision of the remaining half of the stellate ganglion.

5. It is suggested that these are examples of abnormal reflexes established as the result of faulty regeneration of pre-ganglionic sympathetic pathways.

6. An alternate explanation is given for the apparent hypersensitivity of the sweat-glands in patients exhibiting abnormal localized areas of sweating with eating.

7. A case is made out for the hypothesis that pre-ganglionic fibres serving gustatory reflexes travel in different pathways from fibres concerned in thermo-regulatory mechanisms.

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REFERENCES

André-Thomas, and Bars, F. (1927), *Rev. neurol.*, **2**, 63.
Brown-Sequard, C. E. (1850), *C. R. Soc. Biol., Paris*, **1**, 104.
Dale, H. (1935), *Proc. R. Soc. Med.*, **28**, 319.
Ford, F. R. (1953), *Arch. Neurol. Psychiat., Chicago*, **29**, 1279.
Frey, Lucie (1923), *Rev. neurol.*, **2**, 97.
Glaisser, D. H., Hearnshaw, J. R., Heffron, P. F., Peck, A. W., and Patey, D. H. (1958), *Brit. med. J.*, **2**, 942.
Haxton, H. A. (1948), *Brain*, **71**, 16.
Herxheimer, A. (1958), *Brit. med. J.*, **1**, 688.
Langenskiold, A. (1946), *Acta chir. scand.*, **93**, 294.
Murray, J. G., and Thompson, J. W. (1957), *Brit. med. Bull.*, **13**, 213.
Payne, R. T. (1940), *Lancet*, **1**, 634.
Ross, J. P. (1953), *Ann. R. Coll. Surg. Engl.*, **13**, 356.
Simmons, H. T., and Sheehan, D. (1937), *Lancet*, **2**, 788.
Souques, A. (1927), *Rev. neurol.*, **2**, 145.
Uprus, V., Gaylor, J. B., and Carmichael, F. A. (1934), *Brain*, **57**, 114.
Uttl, K. (1932), *Bratisl. lek. Listy*, **12**, 58.
Wilson, W. C. (1936), *Chn. Sci.*, **2**, 273.

A FATAL CASE OF TRACHEOBRONCHIAL RHINOSPORIDIOSIS

By C. S. V. SUBRAMANYAM and A. V. RAMANA RAO

FROM THE DEPARTMENT OF PATHOLOGY, ARMED FORCES MEDICAL COLLEGE, POONA, INDIA

RHINOSPORIDIOSIS is believed to be caused by the fungus *Rhinosporidium seeberi* (Wernicke). It has a predilection for mucous membranes. In this paper we are presenting what appears to us to be the first fatal case of rhinosporidiosis, the cause of death being obstruction of the trachea due to a rhinosporidial growth. Sixty-two biopsies of rhinosporidiosis, examined in this laboratory during the period 1946–57, are also reviewed.

A large number of cases have been reported from India and Ceylon. The first case in India was seen by O'Kinealy in 1894 at the Medical College Hospital, Calcutta. He and Vaughan studied this case and reported it in 1903. Minchin and Fantham (1905) also studied this material and named the organism *Rhinosporidium kinealyi*. It appears that this condition was seen first by Malbran in 1892 in Buenos Aires. Later in 1896 Seeber had also seen a few cases and thought that this disease was caused by a rhinosporidium. Wernicke was the first to use the name *Coccidium seeberia* in 1900 in one of his lectures. There was no unanimity of opinion about the nomenclature of the aetiological agent till Ashworth (1923) postulated that the causative agent is a fungus and not a sporozoon and he gave it the name *Rhinosporidium seeberi* (Wernicke). He included this in the class *Phycomycetes* and the suborder *Chitridiales*. However, some mycologists consider that it belongs to the class *Ascomycetes* of the order *Endomycetales* and the family *Coccidiodacæ*. Nothing more noteworthy can be added to the life-cycle of this fungus in the human tissues than what was described in the classical monograph written by Ashworth. One of us (A. V. R.) attempted to grow this organism in animals and on synthetic media without success.

Table I.—STATE-WISE DISTRIBUTION OF RHINOSPORIDIOSIS AS SEEN FROM THE BIOPSY RECORDS OF THE ARMED FORCES MEDICAL COLLEGE (1946–57)

STATE	NO. OF CASES	PERCENTAGE	STATE-WISE PERCENTAGE DISTRIBUTION OF TROOPS IN POONA	STATE-WISE PERCENTAGE DISTRIBUTION OF TROOPS IN THE ARMY
Kerala Madras	36 10	74·3	17·0	13·4
Punjab and United Provinces	6	9·6	50·0	47·4
Bombay	4	6·4	20·0	6·5
Nepal	1	1·6	7·0	6·5
Not known	5	8·1	—	—
Total	62			

The route of infection is not yet known. Wright (1922), Allen and Dave (1936), and Mandlik (1937) believe that it is a water-borne infection. The organism probably gains access to the human body mainly through the lacerated nasal mucous membrane. Mackenzie (1933) reported a case of rhinosporidiosis in an Englishman who gave a history of an injury to his nose, which resulted in bleeding, and stated that he used to bathe in a river near Kirkee (Poona).

A study of 62 biopsies of rhinosporidiosis examined in this department revealed that 74·3 per cent of cases are among the people of Kerala State. The percentage of this group of people in the Army is about 15–17 per cent. The percentage of incidence among the personnel of other states and the percentage of these in the Army are shown in *Table I*. People from all states of India are enrolled into the Army and therefore it is inferred from the above that the incidence of this disease is particularly high in this state. The average rainfall in Kerala is about 120 in. per year. Stagnant collections of water are common in the villages. The majority of the male population bathe in the stagnant water tanks. This is yet more evidence in favour of the disease being water-borne. This has yet to be substantiated.

Table II.—INCIDENCE ACCORDING TO AGE-GROUP

AGE (years)	NO.	PERCENTAGE
15–20	10	16·1
21–30	34	55·0
31–40	12	19·3
41–44	2	3·2
Not recorded	4	6·4

Table III.—SITES OF OCCURRENCE IN ORDER OF FREQUENCY

SITES	NO. OF CASES	PERCENTAGE
Nose Part unspecified 36 Inferior turbinate 10 Middle turbinate 1 Superior turbinate 1	48	77·6
Nasopharynx	6	9·6
Lacrimal sac	4	6·4
Oropharynx	2	3·2
Conjunctiva	2	3·2
Total	62	

In our series the youngest person was 15 years and the oldest person 55 years of age (*Table II*).

The commonest site was the nose. The other sites were, in order of frequency, the nasopharynx, lacrimal sac, oropharynx, and conjunctiva (*Table III*).

Recently Thomas, Gopinath, and Betts (1956) have reported what is believed to be the first case of bronchial rhinosporidiosis occurring in a male who had a coexisting nasopharyngeal rhinosporidiosis. In this case, after treating the nasopharyngeal growth, they were able to remove successfully the growth in the right lower bronchus by lobectomy. It had not recurred at the time of reporting. Considering the

FIG. 404.—Shows the rhinosporidial polyps in the trachea and in the right-stem bronchus.

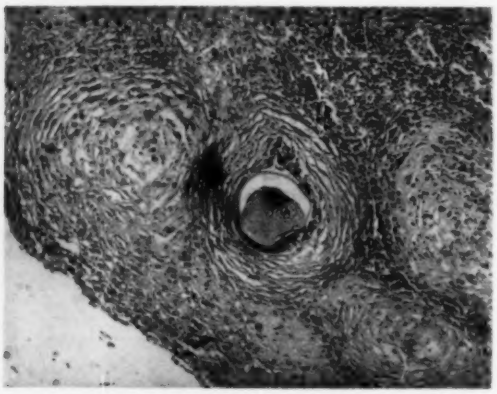


FIG. 406.—Section of the lung showing foci of concentric fibrosis with foreign-body giant cell invading a sporangium. H. and E. (× 80.)

fact that the disease occurs more frequently in the nose than in any other part of the body, it is surprising that extension of the infection to the trachea and bronchi has not been more frequently seen than would be expected on theoretical considerations. In one of Allen and Dave's (1936) patients (*Case* 47), from whom a rhinosporidial mass in the larynx was removed, they considered that the patient would have died of suffocation if the growth had not been removed.

We report below in detail what we believe to be the first fatal case of rhinosporidiosis, in which death is directly attributable to obstruction by rhinosporidial growth of the trachea and partial obstruction of the right bronchus.

CASE REPORT

A Malayalee adult male, aged 30 years, was admitted to the Military Hospital, Poona, on July 23, 1958, complaining of fever, cough, and dyspnœa since a day before admission.

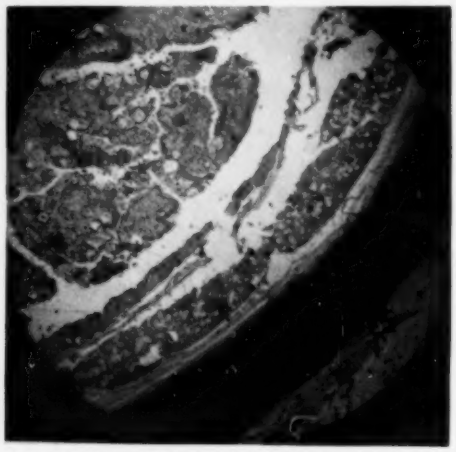


FIG. 405.—Shows the sporangia in the submucous tissue of bronchus. H. and E. (× 54.)

He had been admitted to the same hospital in 1954 for a nasal polyp. The 'tumour' was removed and it was found to be a rhinosporidial polyp.

ON EXAMINATION.—He was a fairly well nourished, febrile, adult in obvious respiratory distress. He was breathing through his mouth. The left nostril was blocked by a greyish-white mass and similar masses of smaller size were seen in the right nostril. The mass projected beyond the soft palate into the nasopharynx. The dyspnœa was inspiratory with stridor, and the lungs, on auscultation, revealed bilateral extensive rhonchi.

He was given penicillin, antispasmodics, and sedatives. He showed some degree of improvement, but was still breathing through his mouth and bringing out thin mucoid sputum. Indirect laryngoscopy showed no growth in the larynx.

AT OPERATION.—On Aug. 3, 1958, most of the masses from the left nostril were removed under local anæsthesia. The masses weighed 30 g. On histological examination the material was found to be rhinosporidial granuloma. As there was much bleeding it was decided to operate on the right side at a later stage.

The patient was feeling much relieved after the operation. The relief lasted for a week. From Aug. 10, the cough, dyspnœa, and mucoid expectoration recurred. At this stage a radiograph of the lungs was taken and it was reported as clear. On Aug. 18 the patient was suddenly roused from his sleep, felt choked, struggled for breath, and fell dead.

AT AUTOPSY.—Both the nostrils were found blocked by greyish-white growths. Both the tonsils and the soft palate were occupied by small sessile warty growths.

The glottis was œdematous. A pedunculated warty mass measuring 3 cm. × 2 cm. was seen arising from the anterior wall of the trachea. The base of the mass was situated 4·7 cm. from the true vocal chords and there was an area of induration over the base of the peduncle. The base was situated just below the isthmus of the thyroid gland. The mass almost filled the tracheal lumen, but was freely mobile on its pedicle.

A similar mass was seen partially blocking the lumen at the origin of the right stem bronchus just below the carina and at a distance of 6·6 cm. from the base of the tracheal mass (*Fig.* 404).

The right lung appeared more emphysematous than the left lung. The medial segment of the middle lobe and posterior basal segment of the lower lobe showed pneumonic consolidation. The cut surface of the middle lobe oozed yellowish pus on pressure. The pleura lining the transverse fissure showed fibrinous exudate. The tracheobronchial lymph-nodes were enlarged.

No noteworthy change was seen in any other organs. The histological examination of the tracheal mass showed it to be a rhinosporidial granuloma. It was covered by pseudo-stratified columnar ciliated epithelium of the trachea. Beneath the mucous membrane were seen a large number of rhinosporidial sporangia in various stages of development (*Fig.* 405). Some of these sporangia showed invasion by foreign-body giant cells. The submucous tissue showed infiltration by chronic inflammatory cells composed of plasma cells, histiocytes, and round cells. The base of the polyp did not penetrate beyond the submucous layer.

Sections of the lung taken from the consolidated areas showed a picture of organizing pneumonia. In one area, in addition to the picture of pneumonia, were seen foci of concentric fibrosis with foreign-body giant-cell invasion of sporangia in the alveoli (*Fig.* 406). The bronchioles showed evidence of acute suppurative bronchiolitis. Histological examination of the other organs did not show any involvement by the disease.

DISCUSSION

For those practising medicine in the tropics this case has several interesting features and, in our opinion, some lessons, too. The occurrence of inspiratory dyspnœa, stridor, and the action of the accessory muscles of respiration and the recurrence of those symptoms, even after removal of considerable portions of the nasopharyngeal mass, should have drawn attention to the possibility of an obstruction to the upper respiratory tract. Indirect laryngoscopy did not reveal any mass in the larynx, but the possibility of a mass lower down the trachea was overlooked. The morbid anatomy of the tracheal and bronchial masses showed only a tenuous attachment to the mucous membrane. It is likely that they may be amenable to removal either by endoscopic manœuvres or by thoracotomy.

In cases so far reported where the larynx or bronchi were involved, there was always a coexistent nasopharyngeal involvement. This indicates that involvement of the upper respiratory tract is secondary to implantation of spores from the nasopharynx. Moreover, in the case described, the tracheal and bronchial masses were well separated by healthy mucosa. Looking at the usual site of election of the disease, namely, the nose and nasopharynx, it is likely that the spores would have been inhaled with the inspired air. In the case described the spores were successfully implanted on the tracheal mucous membrane, resulting in a large growth which caused fatal asphyxia by tracheal obstruction. There was also the complication of pneumonia of the middle lobe and the posterior basal segment of the lower lobe. Naked-eye examination of the segmental bronchi failed to show any extension of the bronchial mass, unlike the case reported by Thomas, Gopinath, and Betts (1956).

We believe that a case of nasopharyngeal rhinosporidiosis with symptoms of cough and dyspnœa out of proportion to the degree of nasal obstruction requires a thorough endoscopic examination of the larynx, trachea, and bronchi. It is only by this means that we can detect early growths and remove them in time. It will be of interest to do routine endoscopic examination of the larynx, trachea, and bronchi in cases of recurrent and long-standing nasopharyngeal rhinosporidiosis. By this means we can estimate not only the incidence of tracheobronchial involvement, but also consider the early removal of any such growths which, if allowed to grow, may lead to serious complications and even death.

SUMMARY

1. A fatal case of tracheobronchial rhinosporidiosis is described together with a brief survey of 62 cases of rhinosporidiosis among the Indian Armed Forces personnel.

2. The importance of endoscopic examination of the larynx, trachea, and bronchi in cases of nasopharyngeal rhinosporidiosis with undue dyspnœa and cough is stressed.

We are grateful to Major J. R. Samuel, under whose care the patient was admitted, for permitting us to publish this case; to Major G. W. G. Bird for his valuable suggestions in the preparation of this paper; to the Professor of Pathology, Armed Forces Medical College, for his encouragement; and to the Director General, Armed Forces Medical Services, for permission to publish the case in this JOURNAL.

REFERENCES

ALLEN, F. R. W. K., and DAVE, M. L. (1936), *Indian med. Gaz.*, **71**, 376.
ASHWORTH, J. H. (1923), *Trans. R. Soc. Edinb.*, **53**, 301.
MACKENZIE, K. W. (1933), *J. Laryng.*, **48**, 107.
MANDLIK, G. S. (1937), *Indian med. Gaz.*, **72**, 143.
MINCHIN, E. A., and FANTHAM, H. B. (1905), *Quart. J. micr. Sci.*, **49**, 521.
THOMAS, T., GOPINATH, N., and BETTS, R. H. (1956), *Brit. J. Surg.*, **44**, 316.
WRIGHT, R. E. (1922), *Ind. med. Gaz.*, **62**, 6.

ENDAURAL CEREBRAL HERNIA

By PETER H. SCHURR

GUY'S-MAUDSLEY NEUROSURGICAL UNIT, LONDON

CEREBRAL fungation is one of many conditions which were once relatively familiar and are now becoming rarities. In the medical journals of the beginning of this century there are many descriptions of post-aural extrusions of cerebrum or cerebellum following mastoid surgery. Other extrusions followed open head injuries, and may still occur when there has been much destruction of the tissues which invest the brain.

The essential feature of an endaural hernia is a defect both in the dura mater and in the adjacent skull through which the brain can herniate. It is necessary for there to be either raised intracranial pressure or local infection, or both, for such herniation to occur (Caboche, 1902). If unprotected brain reaches the exterior it becomes infected, œdematous, and then strangulated. Granulations form, and the lesion is ultimately epithelialized; this is the natural history of a brain fungus. If the protrusion of brain through dura remains covered by superficial tissue, whether intentionally (as in a decompression) or by force of circumstances, it is better referred to as a cerebral hernia (Sargent, 1915).

Fungation used to occur either at the time of mastoidectomy or after an interval of several days or longer. When it appeared immediately, it was usually in those cases in which the dura of the middle or posterior fossa had been opened to drain a suspected cerebral abscess, particularly if there was local brain swelling or raised intracranial pressure. Fungation at a later stage followed accidental trauma to the dura or a negative transaural exploration for a cerebral abscess. The chances of the patient succumbing to infection were high, and epilepsy was an almost invariable sequel in those who survived. This type of brain extrusion is now, fortunately, exceedingly rare. The purpose of this paper is to draw attention to the little known and less obvious post-traumatic endaural hernia which still occurs relatively frequently. When 4 cases were reported by the author at a recent meeting (Schurr, 1958) there were many neurosurgeons present who provided further examples. It is important to recognize an endaural hernia when it is present because of the readiness with which its symptoms may be relieved, and because the condition is potentially dangerous.

CLINICAL FEATURES

Endaural cerebral herniation consists of a prolapse of temporal lobe through a defect in the tegmen tympani and dura mater overlying the middle ear.

Herniation most frequently follows trauma to the dura of the middle fossa during mastoidectomy—either endaural or postaural—but it is an occasional sequel to head injury, as in the case reported by Andrew (1951) in which an endaural hernia was discovered nine years after a fracture involving the middle cranial fossa.

The presenting symptoms may be a persistent aural discharge after mastoidectomy (*Case* 2), pain in the ear or temporal region (Northfield, 1958, and *Case* 3), epilepsy (*Case* 3), or a swelling which appears at the external auditory meatus (*Case* 1). Cerebrospinal otorrhœa (*Case* 1) and cerebral abscess (Bryant, 1909; Verbiest, 1958) are sometimes found as associated lesions or complications of the condition. Recurrent meningitis has been a presenting symptom (Johnson, 1959). This was accompanied by cerebrospinal otorrhœa in an interesting case in which a temporal aerocele had formed in association with the hernia (Johnson, 1953). Although the hernia may occasionally be seen protruding at the external auditory meatus (*Fig.* 407 A), it is usually visible only through an auriscope or after division of the false membrane which may traverse the cavity of a mastoidectomy. It most often appears as a glistening pulsatile swelling in the roof of the middle-ear cavity, but must be distinguished from exuberant granulation tissue or polypus. The swelling usually shows an impulse on coughing, and may sometimes be reduced by pressure and is then seen slowly to resume its previous appearance (*see Fig.* 408 A).

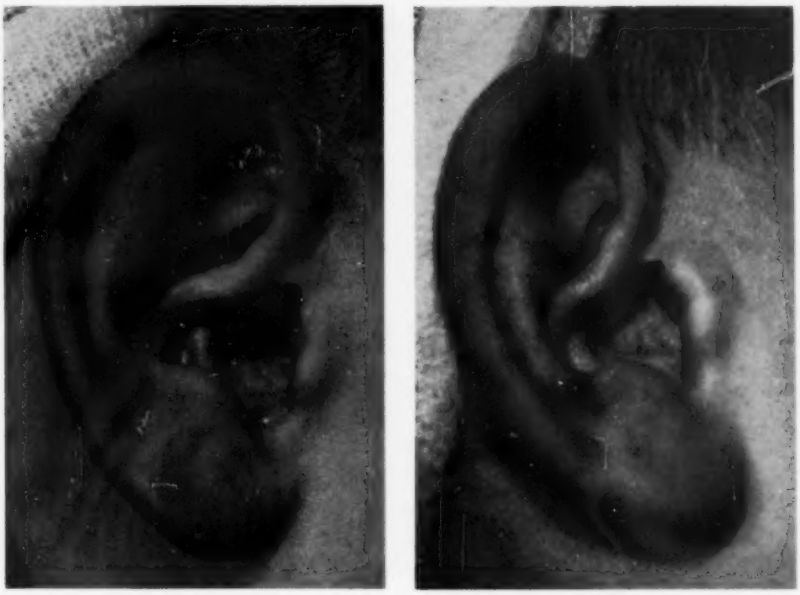
PATHOLOGY

The aetiology is traumatic—whether operative or associated with head injury—a hole being produced in the dura and floor of the middle fossa through which herniation takes place. It is perhaps surprising that the condition does not occur more frequently, but Caboche (1902), Slaviero (1932), and others showed experimentally that for extrusion to occur it was necessary for there to be local infection and swelling, or increased intracranial pressure, or both. Infection may be confined by adhesions (Roques and Huard, 1937), and it is not necessary for clinical meningitis or overt cerebral infection to occur. The brain is usually adherent to the margins of the opening in the dura which form a collar round the hernia. The extrusion is not a meningocele because the dural investment is absent and the arachnoid probably disappears quite soon. Epithelialization takes place and a false sac covers the cerebral tissue. Slaviero has described the histopathology of experimental cerebral hernias in some detail. It is possible that strangulation may occur, for this may have been the cause of sudden swelling of the lesion in *Case* 1. The sequelæ of cerebrospinal rhinorrhœa and cerebral abscess, which have previously been mentioned, show that a later spread of infection can take place. Temporal lobe epilepsy is a manifestation of more distant cortical or subcortical disturbance. Cerebral abscesses were present in 2 of Verbiest's (1958) 3 cases, and this points to the need for careful inspection of the roof of the mastoid cavity of patients who present as cases of temporal lobe abscess. As far as is known, a similar herniation of cerebellar tissue into the operative cavity has not been reported (or at least is not responsible for symptoms).

TREATMENT

The treatment of the condition should be by repair of the dural defect by intradural closure with fascia (Taylor, 1934; Eden, 1942). A small temporal craniotomy is made and a dural flap is turned upwards. The temporal lobe is then elevated from the floor of the middle fossa to expose the neck of the hernia (*see Fig.* 410). The brain has to be freed from its attachment to the orifice by dissection. The opening thus displayed is then widely covered with temporal fascia or fascia lata, allowing 2–3 cm. beyond the defect in every direction. This approach is simple, safe, and effective, whereas attempts to support the hernia endaurally are unlikely to succeed, as the fascia is much less likely to survive (Taylor).

Results of Treatment.—Hardly any reports of treated cases are available, but from personal experience and discussion recurrence is not known to have taken place when an adequate fascial repair has been performed. Chronic aural discharges have improved or ceased. Temporal and aural pain and headaches have been relieved, and epilepsy ameliorated. Finally, further spread of infection to within the skull has been averted.



A B

FIG. 407.—*Case* 1. A, Endaural hernia presenting at the externa auditory meatus. B, Post-operative appearance.

CASE REPORTS

Case 1.—**Endaural cerebral hernia associated with cerebrospinal otorrhœa, headache, and abducent paresis.**

The patient was a girl aged 15 years who had suffered from right-sided otorrhœa for many years. In March, 1952, a modified radical endaural mastoidectomy was performed and the dura of the middle fossa was exposed. Her convalescence was uneventful apart from a temporary facial paralysis, and the ear was dry in a month.

Eight months later a small hernia was found in the roof of the operative cavity. This increased slowly in size during the next six months. Nearly two years after the operation the hernia rapidly enlarged (? strangulated) and appeared at the external auditory meatus (*Fig.* 407 A). The patient developed cerebrospinal otorrhœa and headache together with weakness of the right external rectus muscle. The cerebrospinal fluid showed no pleocytosis and ventriculography was normal. The abducent paralysis may have been due to thrombosis of the superior petrosal sinus (Symonds, 1944). The hernia was repaired by intradural fascial closure as described above and the lesion disappeared from the meatus in three weeks (*Fig.* 407 B). Seven months later it recurred with further headache and aural discharge. It was seen that a small hole leading to the middle ear remained in the floor of the middle fossa. After this had been closed with muscle complete recovery took place, and the symptoms disappeared.

Case 2.—**Endaural cerebral hernia responsible for a chronic aural discharge.**

This man, who was aged 48 years, had suffered from chronic suppurative right otitis media for sixteen years. In June, 1952, an endaural mastoidectomy was performed in which the dura of the middle fossa was penetrated by a gouge. Careful watch was kept for signs of meningitis, but none was seen (although it is possible that they were suppressed by antibiotics); the cerebrospinal fluid remained normal. After two months the ear discharged again and continued to do so. Four months later a pulsatile swelling was seen in the operative cavity. During the next six months it gradually enlarged, and then diminished in size. The discharge continued and in August, 1956, four years later, it was profuse. The hernia was still present (*Fig.* 408 A) and at operation a defect 0·75 cm. in diameter was found in the floor of the middle fossa. Brain had prolapsed through the opening, to which it was adherent (*Fig.* 409). The extruded cerebral tissue was divided and the defect covered by fascia. The discharge

ceased and the swelling within the ear disappeared, leaving a dry cavity with a thin false membrane across it (*Fig.* 408 B).

FIG. 408.—*Case* 2. A, Pulsatile swelling in the roof of a mastoidectomy cavity. B, A year after operation there is a dry cavity with no herniation into it, crossed by a false membrane.

FIG. 409.—*Case* 2. Right temporal cranioplasty. The temporal lobe is adherent to the floor of the middle fossa, and a tongue of brain protrudes through the hernial orifice (arrow).

Case 3.—**Endaural cerebral hernia causing pain and temporal lobe seizures.**

In October, 1950, this 29-year-old woman had a right radical mastoidectomy performed by the post-auricular route on account of suppurative otitis media. The dura of the middle fossa and lateral sinus was exposed. She suffered a temporary facial paralysis after the operation and there was some persistent vomiting, but at no time did she show any sign of intracranial infection.

A month after operation she suffered her first epileptic seizure. An offensive discharge returned and continued for the next three years. Another fit occurred two years after operation, and thereafter they took place at intervals of about three months, despite medication. The fits began with epigastric discomfort, followed rapidly by a sense of tightening of the throat, and then unconsciousness. She complained of pain in the right temple and frequent headaches. The wound was explored in January, 1953, but no significant lesion was seen. In April, 1957, the wound was explored again, this time by the McGucken technique. A web was found, crossing the operative cavity, which had obscured the view of a hernia protruding through a defect in the floor of the middle fossa. This was revealed when the membrane was divided. The aural discharge, epilepsy, and temporal pain continued after this operation. In July, 1957, the hernia could be seen with an auriscope (*Fig.* 410 A). It was repaired with fascia through a temporal craniotomy. The defect measured 0·75 × 1 cm. and contained brain which was adherent to the orifice. A number of fits occurred immediately after the operation, but in the two years and a half that have since elapsed, there have been only two abortive attacks which merely consisted of brief mental haziness. The temporal pain and aural discharge have ceased, and the hernia is no longer seen (*Fig.* 410 B).

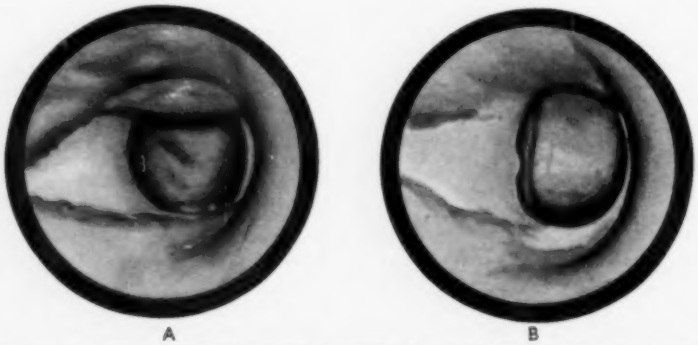


FIG. 410.—*Case* 3. A, Pulsatile swelling in the roof of the cavity of the middle ear. B, Appearance 6 months after operation. The hernia is no longer visible.

SUMMARY

1. The condition of post-traumatic endaural cerebral hernia is described. It is most frequently a sequel of mastoid surgery in which the tegmen tympani has been opened and the overlying dura damaged.

2. The hernia may present at the external auditory meatus or be seen only on auriscopy or after division of a false membrane.

3. Symptoms include chronic discharge, aural or temporal pain, headache, and epilepsy. Associated conditions include cerebral abscess and cerebrospinal otorrhœa, with the possible sequel of meningitis.

4. Treatment should be by means of an intradural fascial repair through a craniotomy.

Acknowledgements.—I am indebted to Mr. Julian Taylor and Mr. Bernard Harries for permission to report *Case* 1, and to Mr. L. F. W. Salmon who kindly referred *Cases* 2 and 3 to me. I am also grateful to the Photographic Department of University College Hospital for *Fig.* 407, and to the Department of Medical Illustration of Guy's Hospital for the remaining figures.

REFERENCES

ANDREW, W. F. (1951), *Ann. Otol., St. Louis*, **60**, 622.
BRYANT, W. S. (1909), *Ibid.*, **18**, 912.
CABOCHE, H. (1902), *Ann. Mal. Oreil. Larynx*, **28**, 278.
EDEN, K. (1942), *Brit. J. Surg.*, **29**, 299.
JOHNSON, R. T. (1953), in *British Surgical Practice. Surgical Progress* (ed. Sir Ernest Rock Carling and Sir James Paterson Ross), 165. London: Butterworth.
— — (1959), personal communication.
NORTHFIELD, D. W. C. (1958), personal communication.
ROQUES, P., and HUARD, P. (1937), *Ann. anat. path.*, **14**, 133.
SARGENT, P. (1915), *Brit. J. Surg.*, **3**, 266.
SCHURR, P. H. (1958), *J. Neurol. Neurosurg. Psychiat.*, **21**, 230.
SLAVIERO, A. (1932), *Arch. Sci. med.*, **56**, 145.
SYMONDS, C. P. (1944), *Proc. R. Soc. Med.*, **37**, 386.
TAYLOR, J. (1934), *Trans. ophthal. Soc. U.K.*, **54**, 312.
VERBIEST, H. (1958), personal communication.

ARTERIAL BOUGINAGE:
A TECHNIQUE FOR BLEEDING DUODENAL ULCER

BY I. S. M. JONES

DEPARTMENT OF SURGERY, KING'S COLLEGE HOSPITAL MEDICAL SCHOOL, LONDON

SEVERE bleeding from a duodenal ulcer is usually due to erosion of the gastroduodenal artery or one of its larger branches on the posterior aspect of the first part of the duodenum. A proportion of cases comes to surgery. Some present extremely difficult technical problems.

At operation, the bleeding artery must be secured and tied. The duodenal wall may be so œdematous that the surgeon is sometimes deterred from a direct attack on the ulcer because of the risks. He may prefer to fall back on 'indirect' procedures such as partial gastrectomy with pre-pyloric closure of the duodenal stump proximal to the ulcer, or vagotomy and gastro-enterostomy. The surgeon hopes that temporary spontaneous cessation of bleeding may become permanent if gastric contents are prevented from pouring over the bleeding ulcerated duodenum. Oversewing the ulcer without defining and ligating the bleeding artery itself is done; but again this is not a certain method of hæmostasis.

Recurrence of bleeding has occurred in the author's personal experience after such indirect procedures, with a fatal outcome in 3 patients. In all of them, a huge posterior duodenal ulcer was present which was virtually irremovable; two were treated by pre-pyloric closure and one had a vagotomy and gastro-enterostomy. Further bleeding occurred within four days post-operatively and all three patients died from hæmorrhage. The mortality from bleeding duodenal ulcer remains high and is variously estimated at between 10 and 20 per cent (Jones, 1956, 1957); the mortality for surgery in bleeding duodenal ulcer for those over 70 years of age is at least 30 per cent (Jones, 1947).

The alternatives may be formidable—probably the most formidable in emergency abdominal surgery. A Polya gastrectomy, with removal of the duodenal ulcer, may be so difficult that adequate, safe closure of the duodenal stump may take a long time in a very ill patient. Failure may produce a duodenal fistula, with its high attendant morbidity and mortality. Even if the duodenal stump is secure, the patient may still die from respiratory complications or from biochemical upsets, some of which follow massive transfusions of citrated blood. Some patients are not fit enough for this long operation. However, surgery may be the patient's only chance of survival if the eroded artery is large. Further, many old people are now being referred for this emergency operation. What is needed is a rapid surgical procedure for the very ill, the frail, and the aged that will stop the bleeding and save life.

An eroded artery in the base of an ulcer continues to bleed because there is a lateral hole in it, i.e., the artery is not completely severed. That a partially severed artery continues to bleed until the patient is exsanguinated is well known to those experienced in war surgery. If the eroded artery is large, fierce bleeding will continue. The mechanism of clotting will not stop the bleeding without arterial retraction. In a partially severed artery, retraction cannot occur. There is no need to postulate either the presence of atherosclerosis in gastric vessels or long-standing periarterial fibrosis. This lateral hole in the artery can be demonstrated at post-mortem examination.

TECHNIQUE FOR LIGATING THE BLEEDING ARTERY

A duodenotomy incision is made. It must be adequate to view the ulcer, but should not extend proximally beyond the pylorus if a Polya gastrectomy is contemplated. The bleeding point is seen as a

mound of clot protruding from the lateral hold in the artery above the ulcer base. This gives the impression that it is the end of an artery sticking up and unable to retract.

If the artery is not bleeding, then stitches should be inserted, trying to guess in which direction the

FIG. 411.—Technique for introducing the bougie and ligating the artery in continuity.

artery is running and so ligate it in continuity on both sides of the bleeding point. *Then the clot should be removed.* If the sutures have been accurately placed, there will be no further bleeding; if not, furious bleeding restarts. Complete and certain arrest of bleeding is the crux of the operation. If bleeding begins after removal of the clot, the hole in the artery should be occluded by the finger, the field sucked dry, and a bougie (plastic or gum-elastic, about a number 8 or 9 French) threaded up the proximal limb of the bleeding artery. This is extremely easy. The artery is intact posteriorly and the bougie slides in along the lumen (*Figs.* 411, 412). The presence of the bougie stops the bleeding and, more important, immediately demonstrates the position of the artery in three dimensions. A non-absorbable stitch (25 linen thread) on a round-bodied needle is inserted under the artery and the first knot tied. As the stitch is pulled tight, its grip around the artery and bougie is confirmed by gently withdrawing the bougie and the knot completed. This procedure is repeated on the distal limb of the artery. The duodenotomy incision is now closed. The artery only has been picked up in the hæmostatic stitch. Usually hæmostasis is difficult in bleeding duodenal ulcer because of the fear of occluding the pancreatic ducts and the common bile-duct.

If the patient's condition is poor, nothing further need be done. The emergency of bleeding is as

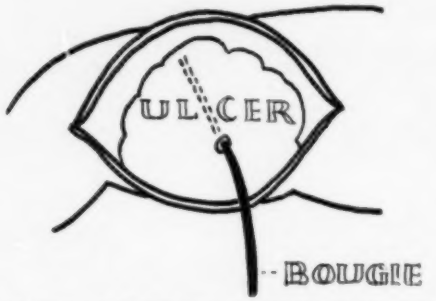


FIG. 412.—The duodenal ulcer exposed, showing the bougie in the arterial lumen.

effectively dealt with as the emergency of perforation is by simple closure of the duodenum. The long-term surgical treatment of duodenal ulcer, such as partial gastrectomy, can be left until another day.

After ligating the bleeding artery, if it is decided to perform a Polya gastrectomy, Bancroft's valuable pre-pyloric closure of the duodenal stump will be necessary in view of the duodenotomy already undertaken. Normal closure of the duodenum will not be possible because of the œdema and ulceration already present, and because of the inversion necessary to close the duodenotomy incision.

SUMMARY

A method is described in which bougies are used to define and ligate the artery bleeding in the base of a duodenal ulcer. It is quick and certain and is unlikely to be followed by duodenal fistula. This procedure of arterial bouginage does work; it has been tried very successfully by the author several times. The certain ligature of the bleeding point may enable the surgeon to avoid an extensive procedure in an ill, frail, or aged patient.

I wish to thank Mr. Harold C. Edwards, Director of the Department of Surgery, King's College Hospital Medical School, for his help and encouragement, and Mr. J. Powley for his fine illustrations.

REFERENCES

JONES, F. A. (1947), *Brit. med. J.*, **2**, 441, 477.
— — (1956), *Gastroenterology*, **30**, 166.
— — (1957), *Brit. med. J.*, **1**, 719, 786.

BLADDER PAPILLOMA

AN ANALYSIS OF 75 CASES

By NOEL THOMPSON*

FORMERLY SURGICAL REGISTRAR, ROYAL VICTORIA INFIRMARY, NEWCASTLE UPON TYNE

THIS analysis is based upon those patients suffering from growths of the urinary bladder, treated over a period of ten years in the general surgical wards of a teaching hospital by a unit working under the direction of a general surgeon (Mr. John Brumwell) having a special interest in genito-urinary surgery.

MATERIALS

Of the 146 consecutive patients treated for growths of the bladder between 1947 and 1956, 71 patients were suffering from infiltrating tumours which have been reported elsewhere (Thompson, 1959). The remaining 75 cases of non-infiltrating papillary growths are dealt with below.

All patients except 4 (5·3 per cent) have been successfully traced, and all other survivors have received recent cystoscopic inspection of the bladder.

CLASSIFICATION

The separation of the non-infiltrating papillary growths considered here from other growths having infiltrating qualities often depended upon cystoscopic appearances interpreted in conjunction with the findings on pelvic examination. Although during the last three years of the survey most growths received initial endoscopic biopsy, prior to this period biopsy material only became available in those cases where the bladder was opened at operation.

Table I.—SITE INCIDENCE OF PAPILLOMATA

Site in Bladder	*Papillomata*	
	No. of Cases	*Percentage*
Base	62	83·0
Lateral wall	3	4·0
Anterior wall	1	1·2
Neck	—	—
Fundus	2	2·6
Generalized papillomata	7	9·2
Total	75	100·0

This lack of histological data in all cases is not considered of absolute importance. Dean (1948) believed endoscopic biopsy to be accurate in less than 50 per cent of cases, owing to the varying cellular appearances present in different parts of the tumour mass, and Kligerman, Robinson, Fish, and David (1952) also found pre-operative biopsy of little value.

Riches (1952) and Winsbury-White (1953) both rely upon the cystoscope to detect infiltrating growths, and Band (1950) has stressed that in a small minority of cases where the cystoscopic diagnosis has been considered a benign papilloma, the failure of the tumour to respond immediately to diathermy and a close follow-up soon reveals the true nature of the lesion.

Since it is usually impossible to distinguish between simple papilloma and non-infiltrating papillary carcinoma by cystoscopy alone, no clinical distinction is made between these pathological entities. As each is amenable to treatment by perurethral cystodiathermy, this factor is believed to be of limited practical relevance.

INCIDENCE

Site (*Table I*).—Of the 75 cases of bladder papillomata, 54 (72 per cent) were single growths and 21 (28 per cent) were multiple growths when first seen; this gives a ratio of single to multiple growths of 2·6 to 1.

The commonest site of occurrence was the posterior wall of the bladder, which was solely involved in no less than 62 cases (83 per cent), usually in the immediate vicinity of the ureteral orifices (47 cases, 62·7 per cent), and less often on the posterior wall of the bladder above the trigone (12 cases, 16 per cent). In only 3 cases (4 per cent) were growths present on the trigone itself.

Table II.—AGE INCIDENCE OF PAPILLOMATA

AGE (years)	MULTIPLE PAPILLOMATA	SINGLE PAPILLOMATA	TOTAL
20–29	—	1	1
30–39	2	4	6
40–49	1	12	13
50–59	4	22	26
60–69	11	10	21
70–79	3	4	7
80–89	—	1	1
Total	21	54	75

Multiple papillomatosis, when it occurred, did so less frequently in basal growths than in those occurring elsewhere. Thus of 62 cases of basal growths, only 11 (18 per cent) showed multiple lesions, but of 13 cases of papillomata occurring elsewhere than on the base, 10 (77 per cent) were of multiple type. Many urologists regard multiplicity as associated with malignancy, so that this distribution is in accord with the widely accepted view that growths of the bladder base are less malignant than those situated elsewhere.

Age (*Table II*).—Of the 75 cases, 47 (63 per cent) occurred in the sixth and seventh decades of life. The youngest patient was 28 and the oldest 82 years old.

Sex (*Table III*).—Of the 75 patients, 62 (83 per cent) occurred in males; a ratio of male to female of 4·8 to 1.

PRESENTING SYMPTOM

Quite the most commonly encountered presenting symptom was hæmaturia, which was almost always painless, and always intermittent. It was present in 72 patients (96 per cent) as an initial symptom, but ultimately developed in all patients.

* Present address: Plastic Surgery and Jaw Injury Unit, Stoke Mandeville Hospital, Aylesbury, Bucks.

Dysuria occurred in one patient where the growth was associated with intravesical calculi; hypogastric pain occurred in one patient with multiple papillomatosis; frequency of micturition occurred in one patient, presumably from trigonal irritation.

It is widely recognized that successful tumour therapy is dependent upon early diagnosis more than on any other single factor. In this series the avoidable delay intervening between the presenting symptom appearing and the patient first attending hospital averaged 8 months, between the extremes of 3 days and 6 years. In 23 cases (30 per cent) the avoidable delay before attending hospital exceeded 6 months.

Table III.—Sex Incidence of Papillomata

Sex	*Multiple Papillomata*	*Single Papillomata*
Male	16 (76 per cent)	46 (85 per cent)
Female	5 (24 per cent)	8 (15 per cent)
Total	21 (100 per cent)	54 (100 per cent)

Some support was found for the contention of Wallace (1956) that multiple papillomata result from widespread mucosal change rather than from secondary seedling implantation from a long-neglected single papilloma. Thus, when 21 cases of multiple papillomata were compared with 54 cases of single growths it was found that symptoms had been present for almost identical average periods in the two groups (8·5 and 8 months respectively).

Furthermore, in 7 cases clear evidence existed in the records to show that recurrences following cysto-diathermy did not occur at the site treated, but elsewhere in the bladder. In these patients from 3 to 8 different sites were involved in each bladder, repeatedly diathermized over periods of from 5 to 10 years; in one patient 8 different sites were involved over a period of 6 years.

This finding is in accord with the discovery of Melicow (1952), who, on painstaking microscopic study of the apparently normal mucosa in 10 bladders removed at cystectomy operations for growths, demonstrated foci of hyperplastic epithelium in all these bladders, reflecting the abnormally increased cellular activity and epithelial liability present.

TREATMENT

(*Table IV*)

Perurethral cysto-diathermy formed the basic initial treatment in all cases where the papillomata were single or few in number, and less than 2·5 cm. in diameter. It has formed the sole therapy used in 43 patients; others have begun with this measure, but, because multiple lesions could not be controlled, or because malignant change supervened, have progressed to more radical treatment.

In all, 15 patients have received surgery alone (apart from cysto-diathermy), and 17 patients have been treated by surgery combined with radiotherapy.

Of the 71 traced patients, 9 have died, but only 4 (5·6 per cent) of their bladder lesion. One patient has died following operation, giving an operative mortality of 1·4 per cent; this was a patient who died of renal failure following routine cystoscopy.

1. Perurethral Cysto-diathermy.—Treatment using a diathermizing cystoscope has proved applicable, unassisted by other means, in 43 (57·3 per cent) of the 75 cases. This compares with the experience of Hollands (1950), who found that of 184 cases of papillomata, 50 per cent could be successfully treated by cysto-diathermy (35 per cent being free of recurrence, and 15 per cent having a low rate of recurrence able to be controlled by repeated perurethral diathermy).

Table IV.—Treatment of Papillomata

Therapy	Total Cases	Cases without Recurrence		Cases with Recurrence		Cases Dead			Untraced
		No.	Percentage	No.	Percentage	Total No.	Bladder Cause	Other Cause	
Cysto-diathermy	43	23	59·0	16	41·0	2	—	2	2
Surgery only	15	5	33·3	3	20·0	6	3	3	1
Open diathermic excision	11	3	27·0	3	27·0	4	1	3	1
Partial cystectomy	1	1	100·0	—	—	—	—	—	—
Total cystectomy	3	1	33·3	—	—	2	2	—	—
Surgery with radiotherapy	17	14	82·4	1	5·9	1	1	—	1
Open diathermic excision + radon	7	5	71·4	—	—	1	1	—	1
Open diathermic excision + cobalt	2	2	100·0	—	—	—	—	—	—
Open diathermic excision + radium ovoids	2	1	50·0	1	50·0	—	—	—	—
Partial cystectomy + radon	1	1	100·0	—	—	—	—	—	—
Cysto-diathermy + radon	2	2	100·0	—	—	—	—	—	—
Cysto-diathermy + colloidal gold	2	2	100·0	—	—	—	—	—	—
Cysto-diathermy + deep X-ray therapy	1	1	100·0	—	—	—	—	—	—

Of these 43 patients, 2 (4·6 per cent) have died of unassociated causes (1 of fatal hæmatemesis and 1 of cardiac failure), and 2 (4·6 per cent) have not been traced.

Of the 39 traced survivors, 16 patients (41 per cent) continue to require periodic diathermy to maintain control of the bladder lesion, and 23 patients (59 per cent) are free of recurrence.

Three patients continuing to receive intermittent diathermy, following similar treatment over prolonged periods of 3–6 years, now present at the site of the former lesion an irregular area of moss-like appearance, resembling the pile of velvet cloth. They are suspected of having undergone a change in character into non-infiltrating carcinoma, as described by Poole-Wilson (1950), and the early use of intracavitary irradiation is considered.

The imperative need for maintained periodic cystoscopic inspection in cases treated by this method is demonstrated by a female patient in whom recurrence of a villous papilloma followed 14 years' freedom from growth. Recurrence after an even longer period of 28 years has been recorded (Winsbury-White, 1953).

2. Surgery.—Of the total of 75 cases, 15 (20 per cent) received surgical intervention in excess of cysto-diathermy, but unaided by radiotherapy.

Of these 15 cases, 6 (40 per cent) have died (3 of malignant recurrence in the bladder, and 3 of unassociated causes); 3 (20 per cent) have recurred after more than 5 years' freedom from growth; 5 (33 per cent) are alive and free from present recurrence; 1 case (6·7 per cent) has not been traced.

Surgery has been applied in three forms:—

a. Open Diathermic Excision.—Of the 15 patients treated by surgery, 11 (73 per cent) received suprapubic cystotomy and electrodiathermic excision of the growth.

Of these 11 patients, 4 (36 per cent) are dead (1 of malignant recurrence; 3 of unassociated causes), 3 (27 per cent) show recurrence after periods of 5–10 years' freedom from growth (but these are controlled by periodic cysto-diathermy), and 3 (27 per cent) are clear of present recurrence; 1 case (9 per cent) has not been traced.

All patients suffered from single large papillomata exceeding 2·5 cm. in diameter, except one who had diffuse multiple growths involving much of the bladder, and who died of malignant recurrence 5 years after operation.

The recurrence rate of 36 per cent compares with 31 per cent by Beer (1935) and 45 per cent by Lund and Lundwall (1955).

b. Partial Cystectomy.—This was used in only 1 case (7 per cent) of the 15 treated by surgery. This was a case of malignant recurrence following earlier open diathermic excision. The patient is now free of growth.

Using this operation in similar tumours Franksson (1950) reports a recurrence rate of 50 per cent, and Riches (1957) produced 50 per cent of 5-year survivors.

c. Total Cystectomy with colonic transplantation of ureters was used in 3 cases (20 per cent) of the 15 treated by surgery. All were instances of widespread multiple papillomatosis of the bladder. Of these patients, 2 (67 per cent) are dead after periods of 1 and 2 years respectively (one of malignant pelvic recurrence and the other of ascending pyelonephritis). The remaining patient is free of recurrence.

In such cases of non-infiltrating widespread papillomatosis, Riches (1956) has shown that total cystectomy can play a valuable part; of 36 cases so treated, 22 per cent survived 5 years.

3. Surgery plus Radiotherapy.—Of the total of 75 cases of papilloma, 17 cases (23 per cent) have been treated by a combination of surgery and radiotherapy; it has become the method of choice in recent years in all cases not able to be treated by perurethral diathermy alone.

Of these 17 cases, 1 (6 per cent) has died of renal failure 1 year after operation, 1 (6 per cent) has developed recurrence of growth, and 14 (82 per cent) are alive and free from growth; 1 case (6 per cent) is untraced.

It will be noted (*Fig.* 413) how much higher is the proportion of survivors free of recurrence in this group, when compared with the preceding group treated by surgery alone.

In all, five radiotherapeutic measures were employed in conjunction with three basic surgical procedures, as follows:—

a. Open Diathermic Excision plus Radon-seed Implantation.—This was used in 7 cases (41 per cent) of the 17 receiving combined therapy.

In all cases single papillomata exceeding 2·5 cm. diameter were involved, and following diathermic

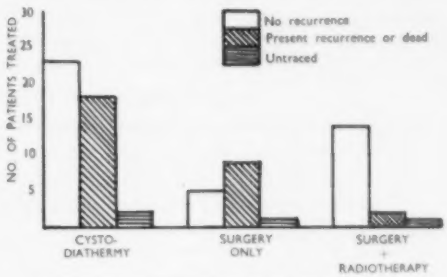


FIG. 413.—Comparison of results of treatment.

excision of the growth at open operation, radon seeds to a total of 4900 r–6500 r were implanted into the base of the growth, under direct vision.

Of the 7 cases, 1 (14 per cent) died of malignant recurrence, and 5 (71 per cent) are free of recurrence; 1 case (14 per cent) is untraced.

This method has received strong support from Poole-Wilson (1957), who, after treating 104 cases of non- and superficially infiltrating tumours, reports a 5-year survival rate of 49 per cent.

b. Open Diathermic Excision plus Radio-active Isotopic Cobalt (Co^{60}) was used in 2 cases (12 per cent) of the 17 cases in this group.

Both were cases of widespread multiple papillomatosis. The radio-active cobalt source was applied in a suitable rubber bag inserted per urethram one month after the larger growths had been diathermically excised at open operation, in a surface-dosage of 5200 r in 24 hours, and 5700 r in 69 hours respectively. Both patients continue free of recurrence.

Poole-Wilson (1957) believes that permanent resolution of multiple papillomata following Co^{60} is exceptional, regarding it as lacking sufficient penetration for use where superficial infiltration is present. Cuccia (1958), on the other hand, advocates the use of intracavitary cobalt in multiple lesions infiltrating beyond the submucosa.

c. Open Diathermic Excision plus Radium Ovoids.—This was used in 2 (12 per cent) of the 17 cases in this group. Both were examples of diffuse papillomatosis. Following preliminary diathermic excision of the larger papillomata at open operation, radium ovoids (each containing 5 mg. radium) were packed into the bladder and removed via the suprapubic wound at a second operation 3 days later. Each bladder received a surface dose of 5000 r in 72 hours.

Of the 2 patients, one is free of recurrence, but the other shows multiple papillomatous recurrences.

The method has not been used in recent years, having been replaced by alternative sources of intracavitary irradiation, or total cystectomy.

d. Partial Cystectomy plus Radon-seed Implantation.—This was used in 1 (6 per cent) of the 17 cases in this group. In this patient multiple papillomata were situated in a large sacculus on the lateral wall of the bladder. Partial cystectomy was followed by implantation of radon seeds along the suture line, in a dosage of 8000 r. The patient continues free of recurrence.

e. Cysto-diathermy and Perurethral Radon-seed Implantation.—In 2 cases (12 per cent) of the 17 in this group, both with recurrent but easily accessible tumours, following earlier cysto-diathermy radon seeds in a dosage of 4500 r in each case were implanted into the affected area, using a perurethral cystoscopic technique. Both patients had previously received intermittent cystoscopic fulguration over periods of 3 years and 8 years respectively, without control of the lesion. Both patients are free of recurrence at present.

f. Cysto-diathermy plus Radio-active Isotopic Colloidal Gold.—This was used in 2 patients (12 per cent) of the 17 in this group.

In both, cysto-diathermy had been followed by repeated recurrences at varying sites. Isotopic colloidal gold was then inserted direct into the two bladders (Ellis and Oliver, 1955) to give a surface dose of 3500 r in 4¾ hours and 1853 r in 2 hours respectively. Both patients are free of present recurrence.

The method has received recent confirmation (Tuovinen and Kettunen, 1957) as producing complete regression of really superficial lesions, where a maximum penetration not exceeding 3·8 mm. is required.

g. Cysto-diathermy and Conventional Deep X-ray Therapy.—This was used in 1 patient (6 per cent) of the 17 in this group. In this case of diffuse multiple papillomatosis, cysto-diathermy proved ineffective in producing control of the lesion, and conventional deep X-ray therapy in a dosage of 2500 r in 14 days was administered.

A single localized recurrence appearing 5 years later was treated by cysto-diathermy, following which the bladder has remained clear of recurrence.

Using conventional deep X-ray therapy in radical dosage in cases of diffuse papillomatosis, Poole-Wilson (1957) has claimed 47 per cent of 5-year survivals; since it is obtained without any operative mortality, such a figure is more than comparable with the results claimed following total cystectomy.

RECURRENCE RATE

Of the 39 traced survivors treated by cysto-diathermy, each has developed an average of 4·6 recurrences, and 33 (85 per cent) have suffered from a recurrence of growth at some time; 16 patients (41 per cent) manifest present recurrences which are still receiving periodic diathermy.

Of the 62 traced survivors treated by all methods, 41 (66 per cent) have suffered from a recurrence of growth at some stage; 20 patients (32 per cent) show present recurrences still receiving treatment. Of the 9 patients dying, 4 died of their bladder condition.

The effect of delay in the introduction of therapy, once symptoms have appeared, upon the death and recurrence rates is shown in *Table V*. From this it will be seen that when traced survivors only are considered, present recurrences are to be found in only 16 per cent of patients delaying less than 6 months before seeking treatment, but in 68 per cent of patients where the delay after onset of symptoms was more than 6 months. Similarly, death-rates in the two groups were 10 per cent and 17 per cent respectively.

Recurrence rates in multiple growths were more than double those in single growths (*Table VI*). Thus of traced survivors, only 24 per cent of single growths have recurred, as compared with 56 per cent of multiple growths; similarly, death-rates from the two groups are 7 per cent and 24 per cent respectively. This is in accord with the experience of Lund and Lundwall (1955), who found that 34 per cent of

Table V.—Relation of Duration of Symptoms to Recurrence Rate

Duration of Symptoms	Untraced		Dead		Present Recurrence		No Recurrence		Total
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.
Less than 6 mth.	4	7·7	5	9·6	7	13·5	36	69·0	52
More than 6 mth.	—	—	4	17·4	13	56·5	6	26·0	23
Total	4		9		20		42		75

Table VI.—Recurrence Rates in Solitary and Multiple Growths

Type of Papilloma	Untraced		Dead		Present Recurrence		No Recurrence		Total
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.
Single	4	7·4	4	7·4	11	20·4	35	64·8	54
Multiple	—	—	5	23·8	9	43·0	7	33·3	21
Total	4		9		20		42		75

solitary papillomata recurred against 73 per cent of multiple tumours, in a series of 183 cases.

Malignant Recurrence.—Of the 71 traced patients, it was judged on clinical and/or histological grounds that 13 (18·3 per cent) suffered from a recurrence of growth, which was malignant in character, at some stage of the survey; in 4 cases (5·6 per cent) this recurrence resulted in the death of the patient.

It has long been recognized that malignant metamorphosis is a dangerous complication of repeated perurethral diathermy applied to non-infiltrating papillomata, and Band (1950) has warned that it may occur as late as 10 years after the introduction of treatment. The proportion in which malignant recurrence may be expected has been estimated as 21·6 per cent of 176 cases (Riches, 1950), 21 per cent of 205 cases (Winsbury-White, 1953), and 20 per cent of 35 cases (Nichols and Marshall, 1956).

Correlation of Histopathology of Growth with Clinical Course.—Criticisms of the partial and inaccurate view of tumour histology which may result from endoscopic biopsy cannot be applied to the excision biopsy obtained at operation. In such cases where the complete tumour is available, many attempts have been made to correlate the clinical course with the growth histopathology, with varying success.

Willis (1948) has warned of the dangers inherent in such attempts in the following unequivocal terms: "The prognosis of any case of urinary tract tumour is uncertain. This is because recurrence by multiple tumour formation occurs in a considerable proportion of cases initially regarded as benign, and because with the lapse of time repeated recurrences are apt to assume increasingly dangerous characters, and to terminate eventually in invasive growth and metastasis."

This view is supported by Ewert and Summons (1951), who were "impressed by the inability to determine the prognosis from the pathological report", but opposed by Lund and Lundwall (1955), who found that histological examination "afforded excellent diagnostic and prognostic support".

In this series the degree of correlation between clinical course and histopathological appearances has been fairly close, but not significantly so.

Of 19 patients where full pathological and follow-up details are available, only one followed a clinical course distinctly at variance with that suggested by the histological report. This was a case of widespread multiple papillomatosis treated by total cystectomy; the operation specimen was reported on as "multiple villous papillomata, showing poor differentiation in one area, but no evidence of carcinoma". The patient died of multiple malignant metastases within 6 months.

Of the remaining 18 cases, 8 were reported on as uncomplicated villous papillomata, in which excision of the growth was followed by death from an unassociated cause (2 cases), villous recurrence elsewhere in the bladder (1 case), or apparent cure (5 cases); 2 cases showed a sufficient degree of dedifferentiation in villous papillomata to suggest the possibility of recurrence, which in fact developed 6 years and 3 years later; 8 further cases, reported as having suspicious histological appearances suggestive in some degree of malignancy, have not so far produced recurrence, but have only been followed up for periods of 2–9 years.

DISCUSSION

The occurrence of hæmaturia as a presenting symptom in 96 per cent of patients in the series, when combined with the knowledge that the tumour recurrence rate is increased four times by delaying more than six months after symptoms appear before seeking treatment, must sufficiently underline the urgent need for early investigation of every such case of hæmaturia. As Badenoch (1956) has stressed, 60 per cent of all cases of adult hæmaturia are due to bladder growths.

Cystoscopic diathermy has retained its position as the treatment of choice for the non-infiltrating papilloma of limited size and multiplicity, provided it is accompanied by a rigid follow-up. The recurrence rate of 41 per cent amongst traced survivors in this series may be compared with 39 per cent by Beer (1935), 62 per cent by Akesson (1942), 62 per cent by Warren (1951), 55 per cent by Hollands (1952), and 42 per cent by Lund and Lundwall (1955).

The superior recurrence-free survival-rates of the group treated by surgery combined with radiotherapy (82 per cent), when compared with the group treated by surgery alone (33 per cent) (*see Fig.* 413), is the more notable in that the patients treated by surgery alone represented a selected group whose bladder lesions were initially assessed as being capable of complete ablation by surgical excision alone. The superiority of combined therapy may be well illustrated by patients receiving open diathermic excision. Of those treated by surgery alone only 27 per cent are free of recurrence, but when radon seeds were implanted into the tumour-bed 71 per cent remained clear of growth.

Radon was used routinely in all later cases in the series where partial cystectomy or open diathermic excision was employed. Support is given to the views of Millen (1950), who, using radon implantation in non-infiltrating growths, found that 63 per cent of patients survived 5 years or more.

SUMMARY

An analysis of 75 cases of non-infiltrating papillomata of the bladder is given.

Age, site, and sex incidence are discussed.

Ninety-six per cent of patients presented with hæmaturia.

The effects of delay in the introduction of treatment upon recurrence rate showed that the latter was increased four times in patients delaying six months or more.

Treatment by cysto-diathermy, other surgical means, and by surgery combined with radiotherapy, is discussed. Cysto-diathermy will control the lesion in more than 50 per cent of cases in which it is applicable.

Of patients treated by a combination of surgery and radiotherapy, 82 per cent are free of recurrence as compared with 33 per cent of the cases treated by surgery alone. The use of radon seeds is supported.

Of the patients treated, 18·3 per cent suffered a recurrence of growth which was malignant in character.

The correlation of histopathology of growth with clinical course failed to demonstrate any significant relationship.

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REFERENCES

Akesson, N. (1942), *Nord. Med.*, **14**, 1967.
Badenoch, A. W. (1956), *Practitioner*, **177**, 267.
Band, D. (1950), *Brit. J. Urol.*, **22**, 381.
Beer, E. (1935), *Tumours of the Urinary Bladder*. London: Baillière, Tindall & Cox.
Cuccia, C. A. (1958), *J. Urol.*, **79**, 94.
Dean, A. L. (1948), *Ibid.*, **59**, 193.
Ellis, F., and Oliver, R. (1955), *Brit. med. J.*, **1**, 136.
Ewert, E. E., and Summons, H. J. (1951), *Surg. Clin. N. Amer.*, **31**, 653.
Frankson, C. (1950), *Acta chir. scand.*, Suppl. 151.
Hollands, F. G. (1950), *Brit. J. Urol.*, **22**, 342.
— — (1952), *Ann. R. Coll. Surg. Engl.*, **11**, 265.
Kligerman, M. M., Robinson, J. N., Fish, G. W., and David, I. (1952), *J. Urol.*, **68**, 706.
Lund, F., and Lundwall, F. (1955), *Acta path. microbiol. scand.*, Suppl. 105, 118.
Melicow, M. M. (1952), *J. Urol.*, **68**, 261.
Millen, J. L. E. (1950), *Brit. J. Urol.*, **22**, 430.
Nichols, J. A., and Marshall, V. F. (1956), *Cancer*, **9**, 566.
Poole-Wilson, D. M. (1950), *Brit. J. Urol.*, **22**, 414.
— — (1957), *Ibid.*, **29**, 244.
Riches, E. W. (1950), *Ibid.*, **22**, 389.
— — (1952), *Proc. R. Soc. Med.*, **45**, 191.
— — (1956), *Ann. R. Coll. Surg. Engl.*, **18**, 178.
— — (1957), *Brit. J. Urol.*, **29**, 232.
Thompson, N. (1959), *Ibid.*, **31**, 287.
Tuovinen, P. I., and Kettunen, K. (1957), *Brit. med. J.*, **1**, 1090.
Wallace, D. M. (1956), *Ann. R. Coll. Surg. Engl.*, **18**, 366.
Warren, J. W. (1951), *J. Kansas med. Soc.*, **52**, 59.
Willis, R. A. (1948), *Pathology of Tumours*. London: Butterworth.
Winsbury-White, H. P. (1953), *Lancet*, **1**, 757.

A NEW OPERATION TO CURE NASOPHARYNGEAL INCOMPETENCE

By F. T. MOORE, O.B.E.

THE QUEEN VICTORIA HOSPITAL, EAST GRINSTEAD, SUSSEX

Since Mourier in 1764 reported the first successful repair of a cleft velum there has been a controversy as to the merits or otherwise of a particular technique used in the repair. Many dogmatic statements have been made and still are made, often based on inaccuracies or repetitions of teachings that have survived generations of text-books.

The problem of repair of a cleft palate is more complex than the mere surgical obliteration of the cleft. Some patients who obtain normal speech have grossly scarred, shortened, and immobile palates while others who fail to achieve normal speech appear to have good, muscular, mobile palates. It is, however, accepted that in patients with rhinolalia the soft palate appears short or fails to make contact with the nasopharynx during speech. In 1865 Passavant attempted to lengthen atrophic short palates by attaching the uvula to the pharynx. In 1928 Rosenthal described a pharyngeal flap attached to the soft palate. Dorrance in 1925, and others, developed operations designed to increase the length of the soft palate by a 'push-back'. Veau and Borel-Maissony (1943) suggested that in some patients the nasopharynx was abnormally large for a soft palate of normal length to effect closure during speech. Hynes in 1950 described an operation to narrow the nasopharynx and provide a contractile ring at a higher level than Passavant's ridge. This operation was often combined with a 'push-back' of the hard and soft palate. Recently, the introduction of tubed pedicled flaps to close palatal deficiencies and increase the length of the soft velum has received some support, but I believe that the indications for this marathon procedure are rare. Other surgeons have concentrated on the advancement of the pharyngeal wall towards the soft palate. Various substances such as fat, cartilage, bone, and paraffin have been successfully introduced into the retropharyngeal space with mixed results.

The principal conditions which may cause rhinolalia are as follows:—

1. Congenital Suprabulbar Paresis.—Worster-Drought (1950) first described thiscondition. The main lesion lies in the corticobulbar tract, that is, the motor outflow to the tongue, lips, soft palate, pharynx, and larynx. In the incomplete or mildest form of the syndrome the soft palate suffers most with pronounced rhinolalia. Wynn Williams (1958) recently recorded the surgical treatment of 49 patients in whom the soft palate moved poorly or not at all, and on whom he had performed a Rosenthal type of pharyngeal flap with good results.

2. Cleft Palate.—Rhinolalia is present following many surgical repairs of a cleft velum. Surgical cure of the rhinolalia will present the speech therapist with a problem she can tackle. Speech therapy for rhinolalia is more often than not doomed to failure.

3. Submucous Cleft Palate.—This is a rare condition. Calnan (1954) has reported a series of 8 cases.

4. Congenital Short Soft Palate (Calnan, 1954): **Palato-pharyngeal Dysphonia** (Worster-Drought, 1953).—Calnan refers to this condition in 3 cases, but the results of V-Y retroposition of the soft palate were not satisfactory. It is probably the same condition referred to by Veau and Borel-Maissony (1943) in which the nasopharyngeal space was abnormally large. Large lateral recesses behind the posterior pillars of the tonsils are probably the site of the greatest leak of air during speech.

Rhinolalia often follows illnesses such as diphtheria, poliomyelitis, and meningitis, but rarely trauma. Nasal escape of air following adenoidectomy is not uncommon but usually disappears. Rhinolalia following tonsillectomy nearly always requires surgical intervention to cure it.

FIG. 414.—Photograph taken at operation demonstrates a long, soft palate. The uvula is hidden by the gag.

FIG. 415.—The cut edges of the soft palate are shown stippled, and the incisions in the lateral pharyngeal wall and superior surface of the soft palate are shown by dotted white lines.

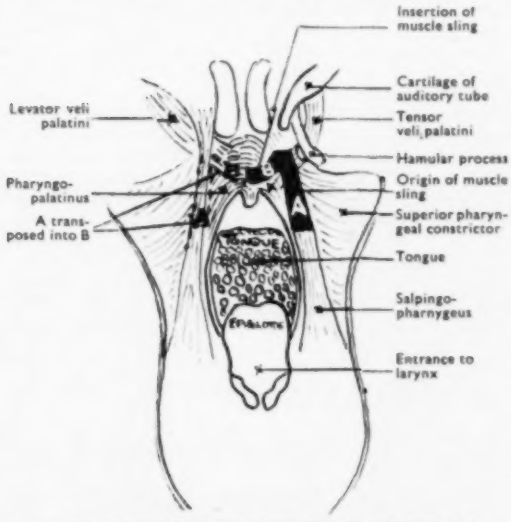


FIG. 416.—A diagram to show a dissection of the pharynx from behind. The superior constrictor muscle has been opened outwards. The origin and insertion of the muscle slings is shown in black shading.

Recently I reviewed 100 patients treated for rhinolalia; 71 had a Rosenthal type of pharyngoplasty and 29 a Hynes type of pharyngoplasty. The following facts emerged:—

1. A 'push-back' or retroposition of the soft palate cured 2 patients. It so often fails because the soft palate is displaced down the pharynx and not upwards and backwards into the nasopharynx.

2. A 'push-back' combined with a Rosenthal type of flap cured 15 patients, but some improvement was observed in all. The pharyngeal flap often tethers the soft palate, preventing it rising during speech.

3. Seven patients were cured by Hynes's pharyngoplasty combined with a 'push-back' procedure.

There are, of course, many factors which must be considered if the interpretation of the 'percentage cure' is to be understood. Twenty-seven children in this series were assessed as below average intelligence, that is, an intelligence quotient below 90. Some had severe hearing loss and others suffered from weakness or inability to move the lips and tongue and pharynx.

In selected patients, that is, those with a high intelligence and rhinolalia as the only complaint, a much higher 'percentage cure' is obtainable with any operation. Even so, it was impossible with the Rosenthal or Hynes type of pharyngoplasty combined with a 'push-back' procedure to guarantee oronasal closure in all cases. For this reason the following operation was developed that had three main objects:—

1. To obliterate the lateral recesses of the nasopharynx.
2. To lengthen the soft palate and produce a mass of tissue on the upper surface of the soft palate where it normally makes contact with the pharyngeal wall.
3. To augment the elevation of the soft palate by a contractile muscular sling.

FIG. 417.—The pharyngeal recesses have been closed by silk sutures and the muscle sling has been transposed to the prepared site by division of the nasal mucosa.

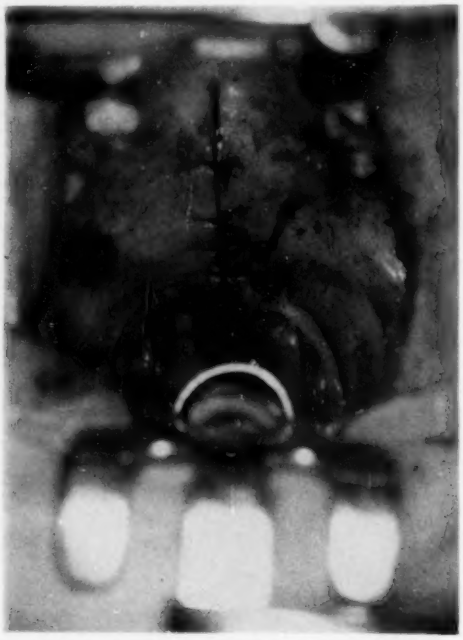
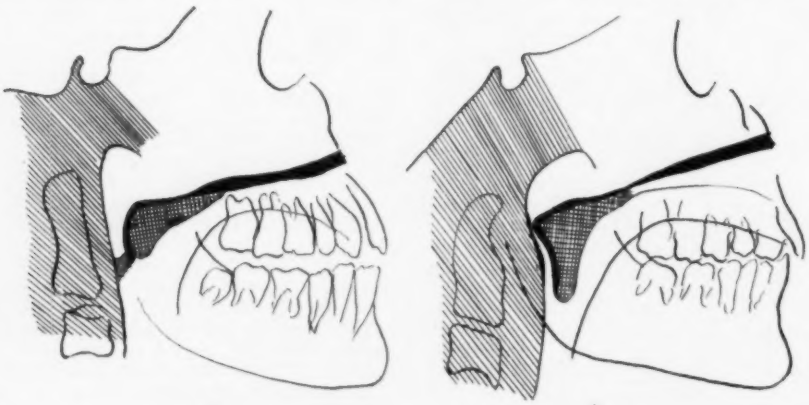


FIG. 418.—Conclusion of operation. Although the palate has been increased in length the muscle sling retracts it into the nasopharynx. Compare with *Fig.* 414.



A B

FIG. 419.—This patient had had a Rosenthal flap performed approximately two years before. Speech was unimproved. A, The patient is attempting to say 'E'. Note how the pharyngeal flap tethers the soft palate, preventing it rising. B, Saying 'E'. Note the decrease in size of the nasopharyngeal space. This patient gained normal speech.

OPERATIVE TECHNIQUE

The patient is given a general anæsthetic maintained through an intratracheal tube passed through the mouth. The nasal airways, nasopharynx, oropharynx,

and soft palate are packed with gauze that has been soaked and well wrung out in a mixture of equal parts of 20 per cent cocaine and 1/1000 adrenaline.

After twenty minutes a mouth gag is inserted and the cocaine packs withdrawn. The midline of the soft palate and lateral recesses of the pharynx are infiltrated with 1/200,000 adrenaline in saline.

RESULTS

In this operative series that I am reporting all the patients were selected, except the first and last. The first patient submitted to operation by this technique was a spastic diplegia with gross rhinolalia and dysarthria. The last patient in this series was an adult suffering from a complete suprabulbar agenetic syndrome.

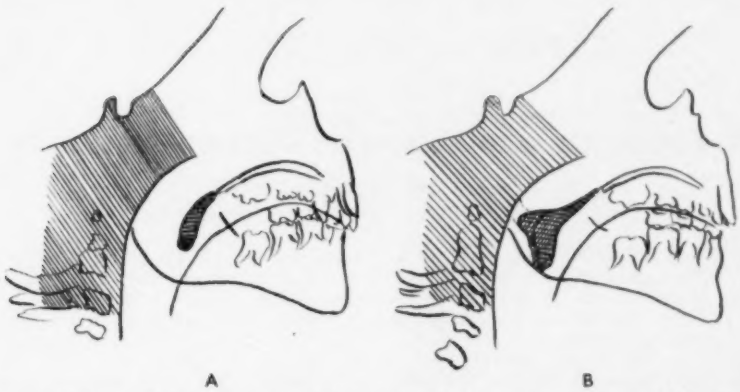


FIG. 420.—A, Patient suffering from a congenital short soft palate or an abnormally large 'pharynx'. B, Following operation in which a 'push-back' was necessary to secure a positive sucker test. This child gained normal speech before leaving hospital.

Approximately 1 ml. is sufficient. A further ten minutes must elapse before the operation begins.

The soft palate is split in the midline. A bulky muscle flap with mucosal cover is dissected up from the lateral pharyngeal recesses similar to those raised in Hynes's pharyngoplasty. The dissection begins 2–4 mm. behind the posterior pillar of the tonsils and sometimes reveals a small portion of the capsule of the tonsil. The width and position of the flap are determined by the size of the lateral pharyngeal recesses (*Figs.* 414–416). The length is easy to judge. The base of the flaps is situated on the postero-lateral nasopharyngeal wall and the nasal surface of the soft palate roughly at the junction of its middle and posterior third. The nasal mucosa is divided so that the muscular sling can be transposed into the defect created by division of the nasal mucosa. The lateral pharyngeal recesses are closed with silk stitches and the muscular flaps are sutured into position (*Figs.* 417, 418).

It will be obvious that a marked increase in length of the soft palate has been gained (*Figs.* 419, 420). The two halves of the soft palate with the muscular slings are carefully united. It will be observed that the soft palate 'arches' into the nasopharynx (*Fig.* 418). The sucker test is now applied. Gentle suction down one nostril, the other occluded, will result in the soft palate being drawn up into the nasopharynx if it is long enough to effect contact easily with the posterior wall of the pharynx. It is necessary to make some allowance for operative œdema and it is better to slacken the mouth gag. If the sucker test is not positive a 'push-back' of the hard and soft palate is performed. This, of course, may involve division of the nasal mucosa from the posterior edge of the hard palate.

She was specially selected for operative photography and X-ray studies. Excluding these two cases 15 children have been operated upon, all of normal or above normal intelligence, all with rhinolalia, but speech fully developed. Five patients were suffering from a suprabulbar agenesis in which the palate only was affected. Three patients suffered from a congenital short soft palate or abnormally wide nasopharynx. Seven patients suffered from cleft palates. None of the children treated suffered from middle-ear troubles or 'stuffy noses', a disadvantage of the Rosenthal and Hynes type of pharyngoplasty. The peculiar resonant note which persists after other methods of repair was also cured.

Twelve of these children obtained normal, spontaneous speech within three months of operation. Three children will require speech therapy, but it is stated that they will attain normal speech in three to six months. These three children had had previous operations on the palate and pharynx.

SUMMARY

A new operation is presented that increases the length of the soft palate, obliterates the lateral pharyngeal recesses, and provides an active muscular sling to augment the normal action of the soft palate.

Acknowledgements.—I am grateful to my colleagues, especially to Mr. John Watson who allowed me to re-operate on one of his cases, Dr. William Campbell who has helped me with the interpretation of the X-ray studies, and Mr. Gordon Clemetson who has photographed this very difficult subject. I am especially indebted to

Dr. Worster-Drought who referred to me and assessed many of these patients.

REFERENCES

CALNAN, J. S. (1954), *Plast. reconstr. Surg.*, **13**, 275.
DORRANCE, G. M. (1933), *Ann. Surg.*, **82**, 208.
ROSENTHAL, W. (1928), *Fortschr. Zahnheilk.*, **4**, 1021.
VEAU, V., and BOREL-MAISSONY, S. (1943), *Mém. Acad. Chir.*, **69**, 1.
WORSTER-DROUGHT, C. (1953), *Med. Pr.*, **230**, 419.
— — (1954), *J. roy. Inst. Publ. Hlth*, **17**, 190.
— — (1956), *J. Laryng.*, **8**, 453.
WYNN-WILLIAMS, D. (1958), *J. Speech Path.*, **1**, 18.

EXPERIMENTAL SURGERY

EFFECT OF LOCAL ANTIHISTAMINES ON GASTRIC SECRETION IN DOGS

BY D. W. BLAIR AND A. P. M. FORREST
UNIVERSITY DEPARTMENT OF SURGERY, WESTERN INFIRMARY, GLASGOW

IT has previously been reported from this department that the antihistamine promethazine hydrochloride, applied locally to the gastric mucosa in concentrations of 2–8 mg. per ml., inhibits the secretion of acid to various stimuli (Kay and Forrest, 1956 a, b; 1957; 1958). Its apparent inability to alter the secretion of pepsin suggested that promethazine acted solely on the parietal cell, but the multiple pharmacological actions of the drug did not allow the assumption that this effect was due to antagonism to histamine.

The following study of its effect on the secretion of electrolytes by the gastric mucosa was undertaken to investigate the possibility that the inhibitory action of promethazine hydrochloride resulted from a non-specific toxic depression of the gastric mucosal cells.

METHODS

Tests were carried out in 6 dogs with separated (Heidenhain) pouches of the stomach in which the secretion of gastric juice was stimulated by a subcutaneous infusion of histamine acid phosphate in 0·9 per cent saline, administered at a constant rate by a Palmer injection apparatus. The dose of histamine used in all the experiments was 25 μg. base per kg. body-weight per hour. Dogs were housed under identical living conditions and were fasted for 24 hours before the performance of each test.

The drugs studied were dissolved in distilled water and applied locally to the pouch mucosa by the method previously described (Kay and Forrest, 1956 a). Distilled water was used as the solvent to prevent contamination of the pouch secretion with electrolytes. Irrigation of the pouch with the antihistamines and other drugs was continued for 30 minutes to allow their adequate contact with the gastric mucosa.

In a pilot study on 3 dogs three groups of experiments were performed to study the effect of promethazine hydrochloride (8 mg. per ml.) applied locally to the pouch during and before histamine stimulation. In the first two groups the secretion was collected for ten 15-minute periods after beginning the histamine infusion before the antihistamine wash-out was administered. In one type of experiment histamine stimulation continued, while in the other it was stopped during the 30-minute period of pouch irrigation, juice being collected for at least three hours after the antihistamine wash-out. In the third group of experiments the antihistamine wash-out was given before histamine stimulation was begun.

Control experiments of identical type were also carried out, in which distilled water alone was used to irrigate the pouch.

As this pilot study indicated that significant inhibition took place only when the antihistamine was applied locally to the fasting stomach, i.e., before the histamine infusion was begun, further tests were carried out on 3 other dogs in which a series of drugs were applied locally to the unstimulated pouch. In successive experiments the pouch was irrigated for a 30-minute period with solutions of promethazine hydrochloride 8 mg. per ml., mepyramine maleate 8 mg. per ml., chlorpromazine hydrochloride 8 mg. per ml., and mersalyl 2 mg. per ml. in distilled water. Control experiments were also carried out in each dog, in which distilled water alone was applied locally.

For each type of wash-out two experiments were performed. In the first, histamine stimulation was started immediately after the pouch had been irrigated and the secretion collected for 4–6 hours. In the second experiment histamine stimulation was not given following the wash-out.

During all the experiments juice was collected at 15-minute intervals, the volume measured in millilitres, and the concentration of free hydrochloric acid determined by titration with decinormal sodium hydroxide using Topfer's solution (p-dimethyl aminoazobenzene) as indicator. The juice was then filtered through glass wool and the concentration of total chloride estimated by the method of Schales and Schales (1941) by titration with mercuric nitrate using 5-diphenyl carbazone as indicator. The concentrations of sodium and potassium in diluted aliquots of filtered juice were estimated with an EEL flame photometer.

All results were expressed in milliequivalents per litre and the outputs of hydrogen, chloride, sodium, and potassium ions calculated in milliequivalents per 15-minute period.

RESULTS

Pilot Study (*Fig.* 421). When the infusion of histamine was continued during the wash-out period, irrigation of the pouch with promethazine hydrochloride was without effect on the secretion of hydrogen, sodium, potassium, or chloride ions. When the histamine infusion was stopped during the wash-out a transient inhibition of acid output resulted from the application of promethazine solution to the pouch mucosa. Although this was more marked than in the control tests when distilled water alone was used, the changes in the other electrolytes were not sufficiently consistent to allow any conclusions. When the antihistamine was applied to the fasting stomach before histamine stimulation was started decisive inhibition of acid secretion was produced and a consistent pattern of change in the secretion of other electrolytes emerged. These changes were further studied in the additional experiments reported below.

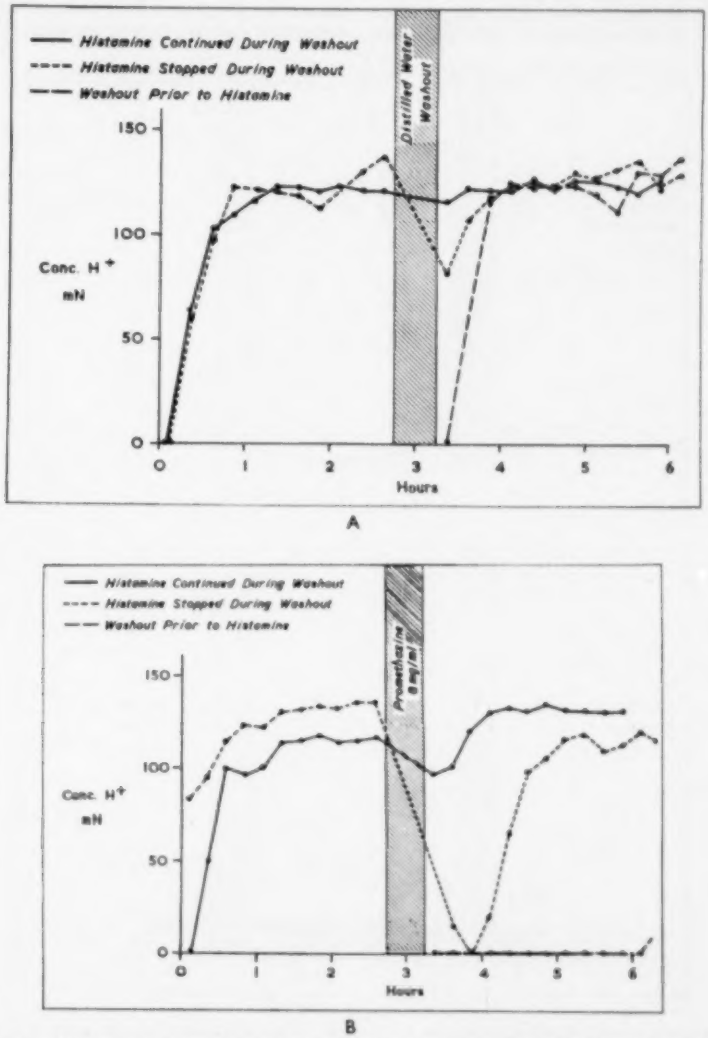


FIG. 421.—The effect of irrigation of a separated pouch of the stomach on the concentration of acid secreted in response to a constant subcutaneous injection of histamine acid phosphate (25 μg. base per kg. body-weight per hour). A, Distilled water wash-out; B, Promethazine hydrochloride wash-out.

Main Study.—

Distilled Water (*Fig.* 422).—Irrigation of the separated pouch with distilled water did not alter the amount or constituents of the fasting secretion. The outputs of sodium, potassium, and chloride ions remained low and no hydrogen ions were present.

When the pouch was stimulated with histamine following the wash-out it secreted highly acid gastric juice with an immediate and sustained rise in the output of hydrogen and chloride ions. As the secretion continued the output of sodium fell; that of potassium remained low throughout.

Promethazine Hydrochloride (*Fig.* 423).—The local application of promethazine hydrochloride, 8 mg. per ml., profoundly inhibited the secretion of hydrogen ions in response to histamine. Instead there was a copious secretion of mucoid and sometimes blood-stained juice which contained sodium and chloride ions in equal amounts. The inhibitory effect lasted for 2 to 4 hours, when hydrogen ions appeared in the juice. The output of chloride rose and that of sodium fell with the increase in hydrogen ions.

When the pouch was irrigated with promethazine hydrochloride (8 mg. per ml.) but histamine not given, a mucoid secretion of similar characteristics was produced for a period corresponding to that of acid inhibition.

Mepyramine Maleate (*Fig.* 424).—As previously noted by Kay and Forrest (1956 a, b), this antihistamine had less inhibitory effect on acid secretion than promethazine hydrochloride. It also caused a smaller amount of mucoid secretion and, in general, the output of sodium remained low. Slight but definite stimulation of mucus secretion followed its application to the pouch when histamine stimulation was not given.

Chlorpromazine Hydrochloride (*Fig.* 425).—The topical application of chlorpromazine hydrochloride in a concentration of 8 mg. per ml. had an identical

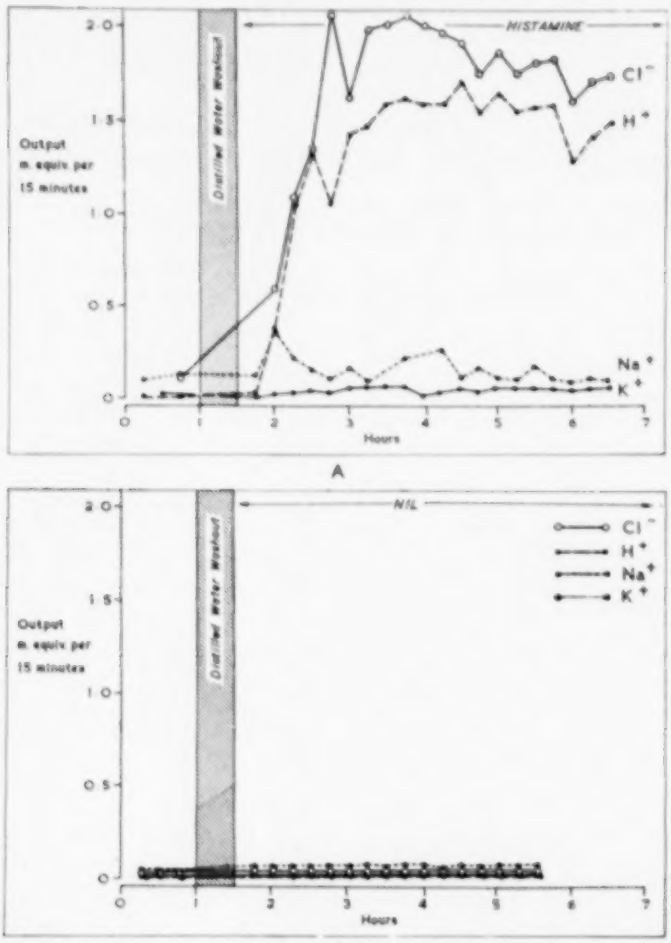


FIG. 423.—The effect of locally applied distilled water on the outputs of electrolytes from a separated pouch of the stomach in a dog.
A, Pouch stimulated by a constant subcutaneous injection of histamine acid phosphate (35 μg. base per kg. body-weight per hour).
B, Pouch unstimulated.

effect with that of promethazine hydrochloride in inhibiting the secretion of acid in response to histamine stimulation. As with promethazine a thick mucoid juice rich in sodium and chloride ions was secreted by the pouch whether histamine was being administered or not.

Mersalyl (*Fig.* 426).—In the concentration used (2 mg. per ml.) mersalyl, applied locally, proved a less potent inhibitor of acid gastric juice than promethazine hydrochloride or chlorpromazine hydrochloride. Its effect on electrolyte secretion was similar, and during the period of inhibition of acid secretion the mucosa secreted a juice rich in mucus, sodium, and chloride ions. This latter effect also followed the application of mersalyl when histamine stimulation was not given.

The total outputs of hydrogen, sodium, potassium, and chloride ions for each test in each dog during the three hours after the wash-out are shown in *Table I*.

DISCUSSION

In dogs and cats histamine stimulates the secretion of gastric juice rich in hydrogen and chloride ions. The outputs of sodium and potassium are low, that of sodium falling as the secretory rate increases (Linde and Obrink, 1950). The effect of applying the toxic agent sodium fluoride to the gastric mucosa of cats secreting in response to histamine was studied by Bond and Hunt (1956). Following application of the drug, the level of hydrogen ions fell while that of chloride ions remained high, ionic equilibrium

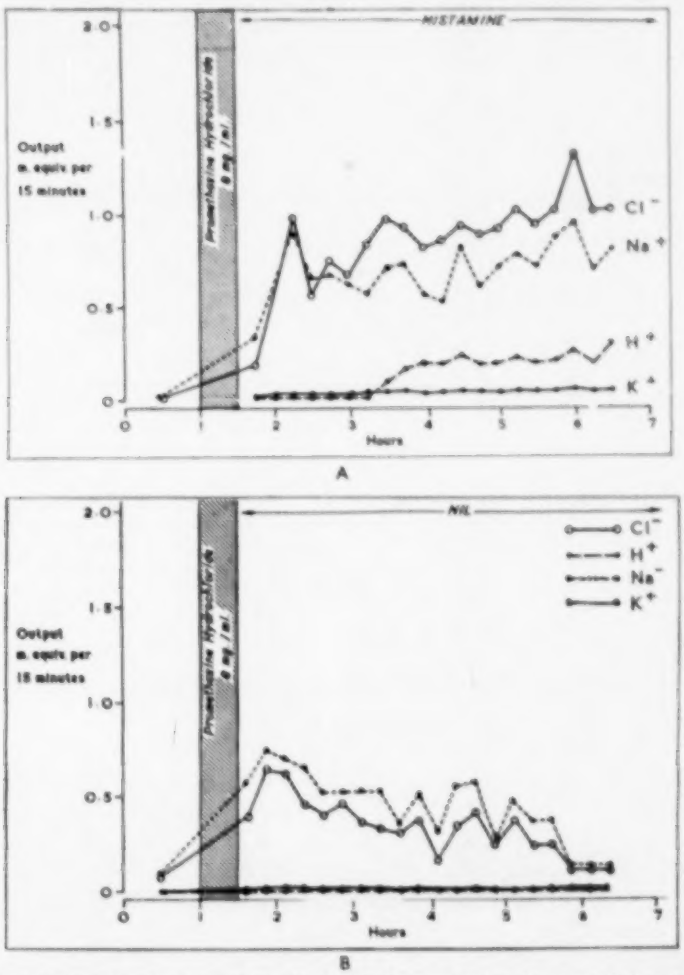


FIG. 423.—The effect of locally applied promethazine hydrochloride (8 mg. per ml.) on the outputs of electrolytes from a separated pouch of the stomach in a dog. A, Pouch stimulated by a constant subcutaneous injection of histamine acid phosphate (25 μg. base per kg. body-weight per hour). B, Pouch unstimulated.

being maintained by an increase in the amount of sodium. Experiments using radio-active sodium indicated that this effect of the toxic agent was due to altered permeability of the gastric mucosa.

In this report we have made similar studies of the action of locally applied promethazine hydrochloride and other drugs on the secretion of electrolytes by the gastric mucosa of dogs.

When promethazine hydrochloride (8 mg. per ml.) was applied locally to the fasting stomach and histamine secretion subsequently started, a profound inhibition of secretion consistently occurred. During the period of inhibition a secretion of blood-stained mucus rich in sodium and chloride ions was produced, a similar effect following the application of the antihistamine when no histamine was given. These

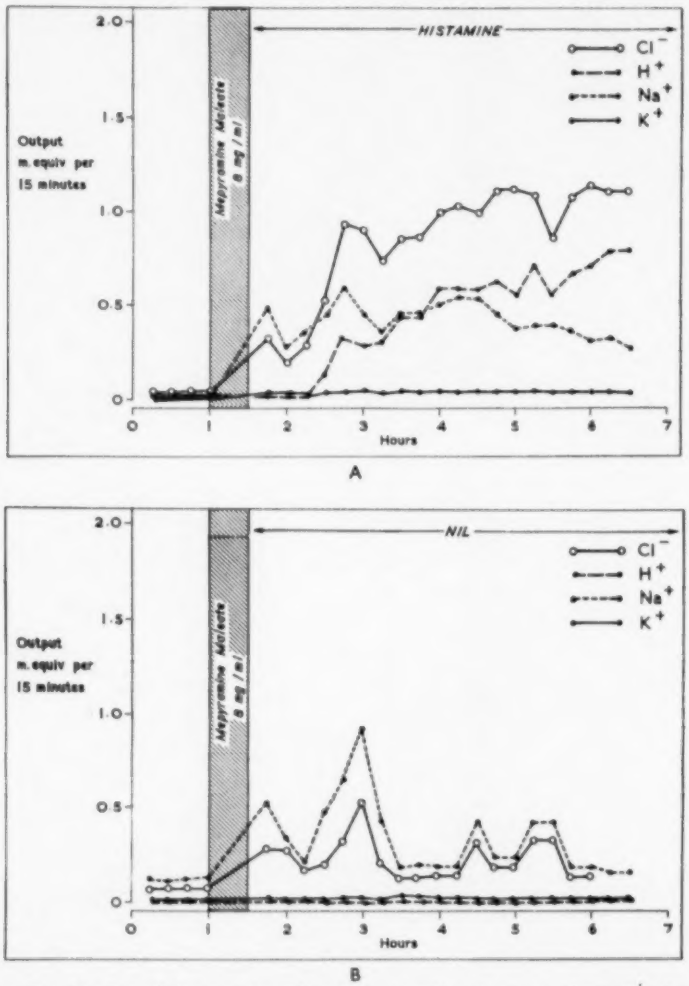


FIG. 424.—The effect of locally applied mepyramine maleate (8 mg. per ml.) on the outputs of electrolytes from a separated pouch of the stomach in a dog. A, Pouch stimulated by a constant subcutaneous injection of histamine acid phosphate (25 μg. base per kg. bodyweight per hour). B, Pouch unstimulated.

When the pouches were irrigated with inhibitory concentrations of promethazine hydrochloride while gastric secretion was being stimulated with histamine, the inhibitory effect was not sufficiently marked to merit further study; this can readily be explained by the failure of the antihistamine to penetrate into the gastric glands against the secretory stream.

experiments clearly demonstrate that promethazine hydrochloride in a concentration sufficient to inhibit acid gastric secretion has a toxic action on the gastric mucosa.

In similar experiments performed with mepyramine maleate less inhibition of acid secretion occurred, and the outpouring of mucus and sodium chloride was less marked. However, the mechanism

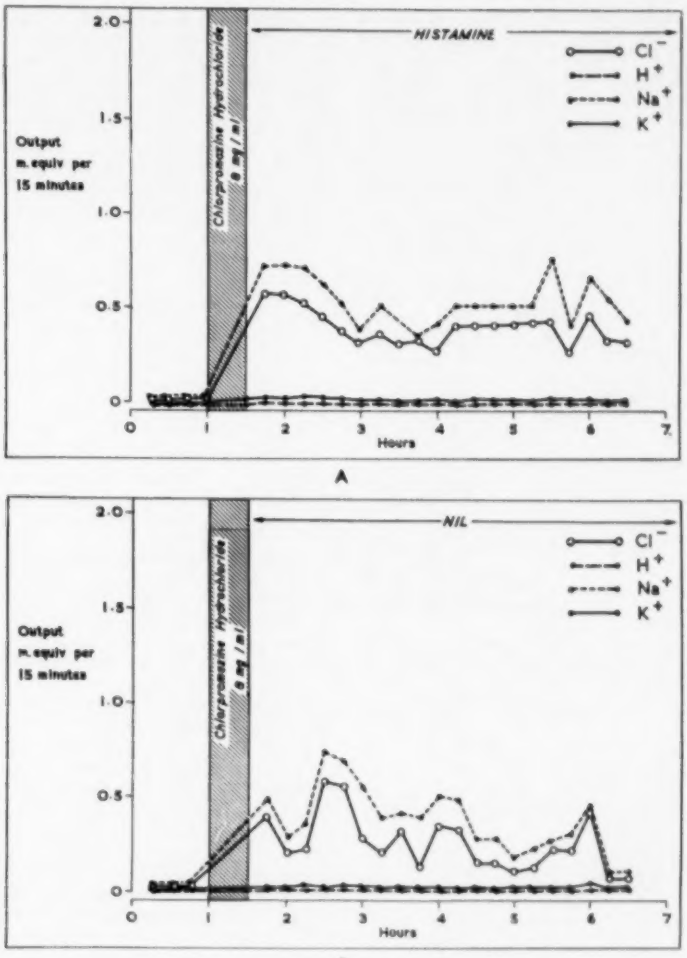


FIG. 425.—The effect of locally applied chlorpromazine hydrochloride (8 mg. per ml.) on the outputs of electrolytes from a separated pouch of the stomach in a dog. A, Pouch stimulated by a constant subcutaneous injection of histamine acid phosphate (25 μg. base per kg. body-weight per hour). B, Pouch unstimulated.

Table I.—TOTAL OUTPUTS OF ELECTROLYTES FOR EACH TEST IN EACH DOG

DOG	Electrolyte	OUTPUT OF ELECTROLYTES (mEq./3 hr.)									
		Distilled Water		Promethazine		Mepyramine		Chlorpromazine		Mersalyl	
		Alone	Hist.*	Alone	Hist.	Alone	Hist.	Alone	Hist.	Alone	Hist.
Rastus	H^+	0	23·513	0	1·579	0	5·868	0	0	0	1·266
	Na^+	·858	4·722	7·163	10·234	4·205†	6·809	6·291	8·254	1·675	4·339
	K^+	·038	1·047	0·173	0·449	0·099†	0·349	0·015	0·205	0·069	0·147
	Cl^-	·506	30·709	5·880	12·666	3·911†	13·609	4·119	6·627	1·411	4·573
Donald	H^+	0	6·428	0	0·607	0	3·471	0	0	0	0·837
	Na^+	·246	0·984	5·465	3·078	0·899	1·353	2·060	5·818	0·674	1·022
	K^+	·017	0·160	0·134	0·210	0·037	0·230	0·201	0·014	0·033	0·115
	Cl^-	·300	8·270	3·872	5·558	0·532	5·333	4·475	5·068	0·471	1·977
Penelope	H^+	0	3·519	0	0·320	0	4·160	0	0	0	4·074
	Na^+	·056	1·330	4·319	3·672	0·273	3·344	1·981	3·019	0·413	3·556
	K^+	·002	0·180	0·126	0·138	0·140	0·346	0·062	0·013	0·017	0·232
	Cl^-	·060	4·445	3·537	3·871	0·337	5·861	1·627	2·909	0·341	5·864

* Hist. = Histamine. † Mean of two tests.

of the inhibition, although of less degree, was similar to that produced by promethazine hydrochloride and by mersalyl, a known toxic agent.

Conclusive evidence that promethazine hydrochloride inhibited gastric acid secretion by its toxic action was afforded by the results of experiments in which chlorpromazine hydrochloride was topically applied in similar concentrations. This drug is chemically related to promethazine hydrochloride and yet has only slight antihistaminic properties (*Fig.* 427). When applied to the gastric mucosa, the resulting inhibition of acid secretion in response to histamine was almost identical to that produced by promethazine, its application resulting in the secretion of a juice rich in mucus, sodium, and chloride ions whether or not histamine stimulation followed irrigation of the pouch.

There is thus no doubt that the local application of promethazine hydrochloride caused a marked irritation of the gastric epithelium with exudation of a mucoid secretion containing sodium and chloride ions. It seems reasonable to suppose that the inhibition of parietal cell activity was due to a similar toxic action.

The failure of topically applied promethazine to influence the secretion of pepsin (Kay and Forrest, 1956 b; 1958) does not alter this hypothesis, as Bowie, Darlow, and Murray (1953) showed that sodium fluoride, a known toxic agent, also had a similar apparently selective effect on acid secretion. It may be that the more differentiated cell is more sensitive to their toxic action or that locally applied drugs have better access to the parietal cell along the intracellular canaliculus.

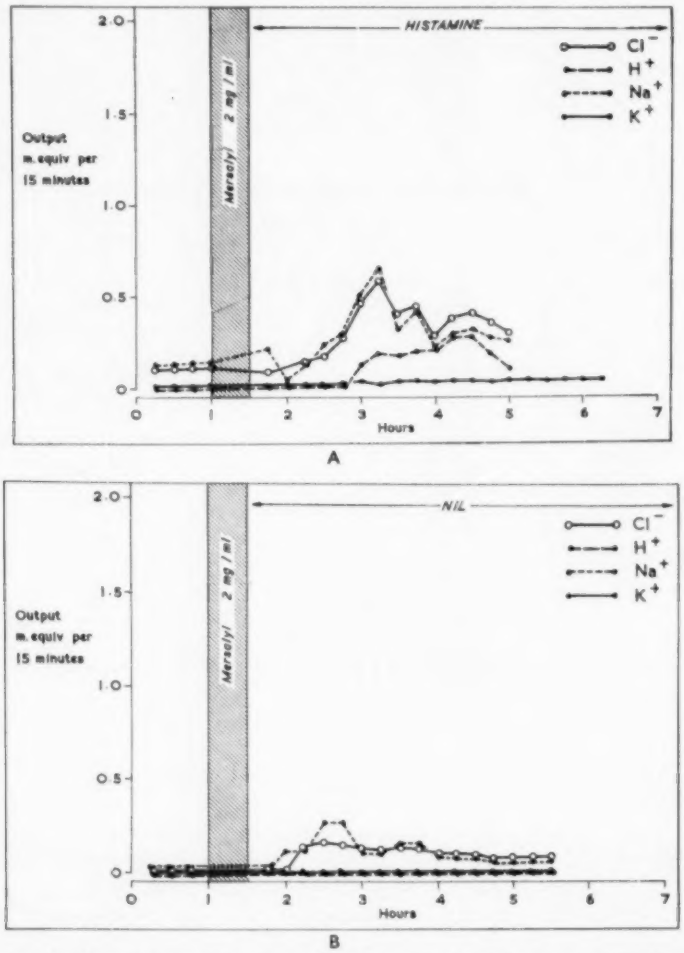


FIG. 426.—The effect of locally applied mersalyl (2 mg. per ml.) on the outputs of electrolytes from a separated pouch of the stomach in a dog. A, Pouch stimulated by a constant subcutaneous injection of histamine acid phosphate (25 μg. base per kg. body-weight per hour). B, Pouch unstimulated.

The non-specific action of the antihistamines in gastric secretion was primarily suspected by Robertson and Grossman (1952) and Ragins, Benditt, Greenlee, and Dragstedt (1958) on the basis of the thick mucoid secretion which followed their application. Robertson and Grossman also found that an antihistamine analogue, compound 01952 2-(-dimethyl-aminoethoxy) 3-chlorodiphenyl methane hydrochloride, had an effect similar to that of the other antihistamines used in their experiments, although the

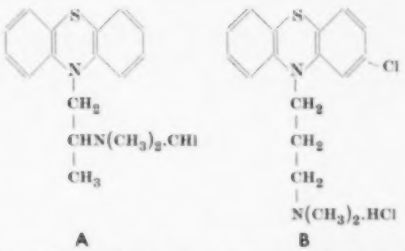


FIG. 427.—Chemical structure of A, Promethazine hydrochloride, and B, Chlorpromazine hydrochloride.

concentrations of these compounds were far in excess of those used by Kay and Forrest, and those in this study.

Further evidence that promethazine hydrochloride has an irritant effect on the gastric mucosa has recently been reported by Ragins and others (1958). In acute experiments on dogs these workers found that 15 ml. of a 0·6 per cent solution applied locally disintegrated the epithelium of the stomach which was partly shed in scattered lumps of epithelial cells in a thick layer of mucus. These appearances have been verified in this laboratory.

There appears little doubt that the inhibitory action of promethazine hydrochloride, an active antihistamine, on the secretion of acid by the gastric mucosa is due to a toxic non-specific effect. The inhibitory action of locally applied antihistamines cannot therefore be taken as evidence that histamine is mainly concerned in the mechanism of gastric secretion.

SUMMARY

In dogs with separated pouches of the stomach the effect of locally applied promethazine hydrochloride, mepyramine maleate, chlorpromazine hydrochloride, and mersalyl on the secretion of electrolytes has been studied.

The results indicate that the inhibitory effect of the antihistamine on acid gastric secretion is non-specific and due to a toxic action on the gastric mucosa.

Acknowledgements.—We wish to thank Professor C. F. W. Illingworth, C.B.E., for facilities to carry out this work in his department, Norman Anderson, Daniel Hamilton, and Miss Mulholland for technical assistance and the Department of Medical Illustration for their help. We are also grateful to Professor R. C. Garry for accommodating the dogs in the Institute of Physiology, and to Professor W. Weipers and Mr. Donald Lawson of the University Veterinary Hospital for help with the care of the animals. Supplies of promethazine hydrochloride, chlorpromazine hydrochloride, and mepyramine maleate were donated by Messrs. May & Baker Ltd.

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REFERENCES

BOND, A. H., and HUNT, J. N. (1956), *J. Physiol., Lond.*, **133**, 317.
BOWIE, J. Y., DARLOW, G., and MURRAY, M. M. (1953), *Ibid.*, **122**, 203.
KAY, A. W., and FORREST, A. P. M. (1956 a), *Brit. J. Surg.*, **43**, 522.
— — — — (1956 b), *Ibid.*, **44**, 97.
— — — — (1957), *Ibid.*, **45**, 293.
— — — — (1958), *Ibid.*, **46**, 282.
LINDE, S., and ÖBRINK, K. J. (1950), *Acta physiol. scand.*, **21**, 54.
RAGINS, H., BENDITT, E. P., GREENLEE, H. B., and DRAGSTEDT, L. R. (1958), *Gastroenterology*, **35**, 1.
ROBERTSON, C. R., and GROSSMAN, M. I. (1952), *Arch. int. Pharmacodyn.*, **90**, 223.
SCHALES, O., and SCHALES, S. S. (1941), *J. biol. Chem.*, **140**, 879.

THE SHEEP AS AN EXPERIMENTAL ANIMAL IN SURGICAL SCIENCE

BY JOHN BORRIE AND R. M. MITCHELL*

DEPARTMENT OF SURGERY, UNIVERSITY OF OTAGO MEDICAL SCHOOL, DUNEDIN, NEW ZEALAND

OVER the past six years sheep have been used for experimental study in over 800 survival operations in the Department of Surgery, University of Otago. The purpose of this paper is to review that overall experience, emphasizing pre-operative care, anæsthesia, and post-operative care, as well as indicating experience with sheep in cardiac, tracheal, pulmonary, peripheral arterial, and renal experiments.

* Present address: Department of Surgery, University of Queensland, Brisbane, Australia.

The Choice of an Experimental Animal.—When one of us (J. B.) inaugurated experimental work in the Department of Surgery in 1952, the problem of the choice of an animal suitable for technical research was at once raised by the Animal Department of the Otago Medical School. Dogs were vetoed, not only because of noise in a city area and heavy maintenance costs in any long-term survival experiments, but also because only short-term holding space was available in the Medical School precincts.

Although no one in the Medical School had had any previous experience with sheep in surgical survival experiments, let alone experience of their pre- and post-operative care, nevertheless the sheep was chosen. It was favoured because it is silent, is readily available at weekly stock markets, is valued only as a commercial animal, is herbivorous, and able to graze itself after operation free of cost. The Invermay Research Farm of the Department of Agriculture of New Zealand, situated 8 miles from the Otago Medical School, generously provided initial grazing facilities.

From the start sheep proved their worth. They have been used successfully in experiments designed to establish methods for correcting atrial septal defects (Borrie, 1953, 1955 a) and mitral regurgitation (Borrie, 1954, 1955 b), as well as in work on division and resuture of the trachea (Borrie, 1957 b), the insertion of freeze-dried arterial homografts into the carotid arteries and also the thoracic aorta with the sheep under hypothermic conditions (Borrie and Woodruff, 1955). In addition, they have been used for placing circumferential sutures around the origin of the aorta below the coronary arteries (Borrie, 1957 a), as well as for major studies on pulmonary reimplantation (Borrie, Campbell, and Fulton, 1958; Borrie and Fulton, 1958; Borrie and Montgomerie, 1958 a, b), and renal transplantation (Mitchell, 1957, 1959 a, b; Mitchell and Woodruff, 1957 a, b).

From time to time new surgical laboratories in Australasia and elsewhere have made inquiries from us about sheep as experimental animals, and it is for this reason that we feel it is opportune to record our experience.

The Purchasing.—Initially sheep were purchased each week as required, either as culls from private farmers or through stock agents from the markets, but since establishing the University Animal Farm at Invermay in 1956 it has been found more satisfactory to buy from the stock markets about every two months in lots of 12.

Romney-over-Southdown wethers weighing approximately 80–100 lb. have proved satisfactory, as have the occasional Merinos. Especially for abdominal work heavier animals are likely to have excessive intra-abdominal fat, rendering intraperitoneal manipulations difficult. Depending on the state of the market at the time of buying, the average cost was £3 (8 dollars) per sheep.

PRE-OPERATIVE CARE

The animals are brought to the Department of Surgery several days before use and housed in animal pens. These measure 7 ft. long by 4 ft. wide, and have a floor covering of sawdust or wood shavings to a depth of approximately 2 in. Electric points for shearing machines are available, and also water taps for any continuous suction that may be required in the post-operative period.

Diet.—The sheep are fed on a diet of hay and sheep-mash consisting of a mixture of maize meal 4 parts, crushed oats 1 part, bran 1 part, and linseed meal ½ part. This mash is kept in a bucket. Although under natural conditions sheep drink very little water, especially with wet, lush grass, under laboratory conditions they drink freely, up to 2 litres a day.

Pre-operative Starving.—Initially food was withheld for twenty-four hours before operation, but as there was a tendency to operative and post-operative gastric regurgitation from the enormous stomach, four years ago this starving period was increased to forty-eight hours, and has proved satisfactory.

General.—The animal is lightly shorn all over, but closely shorn at the incision site and over the front of the neck so as to expose the external jugular veins. Thereafter it is weighed. If the animal is to have anticoagulant therapy this is started four days before operation, using dindevan 600 mg. per day, the tablets being given crushed and in a fluid suspension with a drenching gun. Careful controlled testing with daily prothrombin times established that this large dose was necessary. In experiments involving renal transplantation pre-operative collection of urine and fluid balance studies were started up to a week before operation.

ANÆSTHESIA

Anæsthesia was first required for survival experiments on creating and closing atrial septal defects (Borrie, 1953, 1955 a), and as an anæsthetist was not available, a simple method of mechanical controlled anæsthesia was required.

The following standard equipment was found to be indispensable:—

1. Sterile 20-ml. syringe for intravenous anæsthesia.
2. Sterile small bowl for mixing the anæsthetic agent.
3. Size 21 and a size 17 needle.
4. Long blade Magill laryngoscope.
5. Cuffed endotracheal tube, size 8 or 9.
6. Metal sheath (copper) 9 in. long, to protect the rubber endotracheal tube from being bitten through by the sheep.
7. Metal rod 18 in. long for guiding the pilot tube through the metal sheath (No. 8 fencing wire).
8. 20-ml. syringe for inflating the cuffed endotracheal tube.
9. Palmer pump or equivalent respiratory pump.
10. Towel clip.

The Anæsthetic Pump (*Fig.* 428).—A Palmer* pump was chosen as a simple and effective means of aerating the lungs during thoracic operations. The Palmer pump used was especially made to have a tidal volume of 700 ml. This is much larger than is normally necessary, and experience has shown that the standard pump with a tidal volume adjustable up to 500 ml. is entirely adequate for sheep. The tidal air required was worked out by trial on the first 25 survivals and graphed as a chart of weight against tidal volume. This graph has been in constant use since then and has given no trouble. The line of the graph is not straight, but curves, since weight increase does not parallel increase in tidal volume (*Fig.* 429). For a sheep of 100 lb. a tidal volume of 280 ml. is desirable. The pump, in the first half of its cycle, delivers air to the animal, and in the second half of the cycle allows an escape valve to reduce the pressure to zero. It is found important to have a

* C. F. Palmer & Co., Brixton, London.

water trap on the return tube so as to collect water vapour which otherwise can adversely affect the machinery. The pump is extremely simple and is driven by an electric motor which has been adjusted to 27 strokes per minute. If additional ether is required then it may be drawn into the circuit by attaching a Shipway bottle on the afferent side. In the same way extra oxygen can be added via a T connexion. In practice, however, air is usually all that is required.

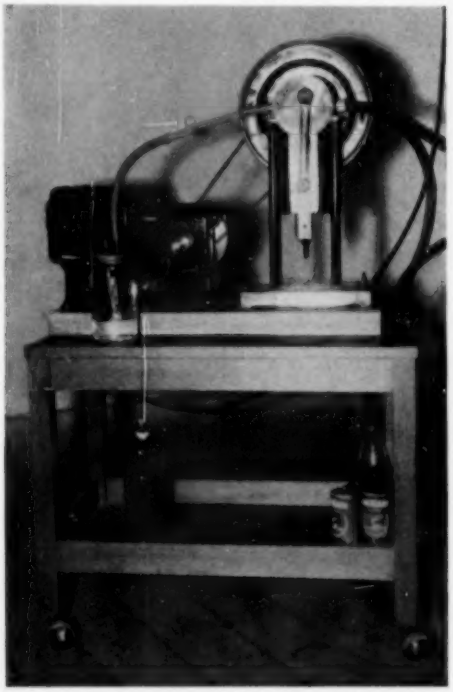


FIG. 428.—The Palmer pump and electric motor mounted on a locally made trolley.

Regarding connexions from the pump to the animal, it is most important to have firm rubber hose connexions on the Palmer pump, and approximately 3 ft. in length. Ribbed rubber garden hose has proved the most durable. The double pipes to and from the pump are connected through a brass Y-piece to the endotracheal tube (*Fig.* 430 D). The rubber hose should be firmly clamped to the Palmer pump, and also on to the Y-piece, preferably with standard metal hose screw clips. Standard wide-bore rubber tube was used at first, but from time to time became kinked or perished, with fatal results.

The pump and motor are firmly mounted on a block of wood and this rests on a trolley fitted with Shepherd* castors, which allows easy movement of the pump as is generally required, for example, when an anæsthetized animal is moved from the operating table to a bath during the induction of hypothermia (*see Fig.* 428). On the second shelf of the trolley it has been found convenient to keep a bronchoscope with appropriate batteries, endobronchial metal aspirating pieces, rubber endotracheal suction tubes, and other equipment necessary for endotracheal work.

Danger Points.—As trained anæsthetists have not usually taken part in this experimental work, and as anæsthesia has in the main been done by surgical technicians, the following points, which at first sight appeared trivial, have all been found important in successful anæsthesia in sheep. Neglect of each one of these has at some time contributed to the death of an animal.

1. Check the inflatable cuff on the endotracheal tube and see that there is no leak (No. 9 or 10 Magill is satisfactory).

2. Check that the endotracheal suction tube will go through the endotracheal tube.

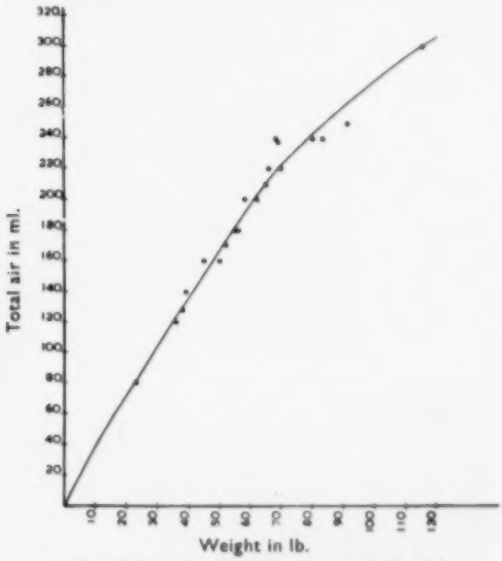


FIG. 429.—Chart showing relation between weight of sheep in pounds (avoirdupois) and tidal air as used with a Palmer pump during intrathoracic operations. (*By courtesy of J. thorac. Surg.*, 1955, **29**, 426.)

3. Check the 10-ml. syringe for inflating the cuff.

4. Check the light on the laryngoscope.

5. Check the weight of the sheep and adjust the appropriate tidal volume on the Palmer pump.

6. Check the attachment of the rubber tubes to the pump and water-vapour trap.

7. See that atropine is ready as well as pentobarbitone sodium (nembutal) and suxamethonium bromide.

8. See that the intravenous needles are not blocked.

9. See that there is a 10–20-ml. syringe for pentobarbitone sodium and a 2-ml. syringe for additional suxamethonium bromide.

10. See that the room can be darkened during intubation.

11. See that the metal sheath is present to protect the tube in the animal's mouth.

* Archibald Kenrick & Sons Ltd., West Bromwich, Staffs.

12. See that the junction of the endotracheal tube and metal Y-piece from the Palmer pump is not kinked.

13. If additional ether is drawn into the circuit, see that it is removed when anæsthesia is deep enough.

14. Check that suction is available and efficient.

Induction of Anæsthesia.—Atropine sulphate gr. $\frac{1}{50}$ (1·3 mg.) is mixed with powdered pentobarbitone sodium taken from the ordinary capsules, on the basis of gr. 1 (64 mg.) to 15 lb. bodyweight. This is dissolved in 10–15 ml. normal saline.

If peroral intubation is required then 60 mg. of suxamethonium bromide are also added. During injection an attendant holds the animal upon its haunches, and the needle is inserted into either one of the external jugular veins, which in the sheep are large vessels, made very obvious by thumb pressure over the root of the neck (*Fig.* 430 A). When the injection has been given and the animal is ready for intubation it is lifted on to its back on the operating table, a block placed under its neck, the Magill laryngoscope with a long blade inserted, the lower jaw raised, and the endotracheal tube held straight on a narrow metal rod quickly inserted through the larynx (*Fig.* 430 B). Sharp digital compression on the chest (not the stomach) will check that the tube is in correct position by a sharp blast of air coming out. At this point the metal rod is removed, put into the mouth of the pilot tube and then fed through the copper sheath, which is thereafter guided into the mouth (*Fig.* 430 C). The cuff is next inflated. The rubber endotracheal tube is then connected to the Palmer pump, and the whole held firmly in position by the following means.

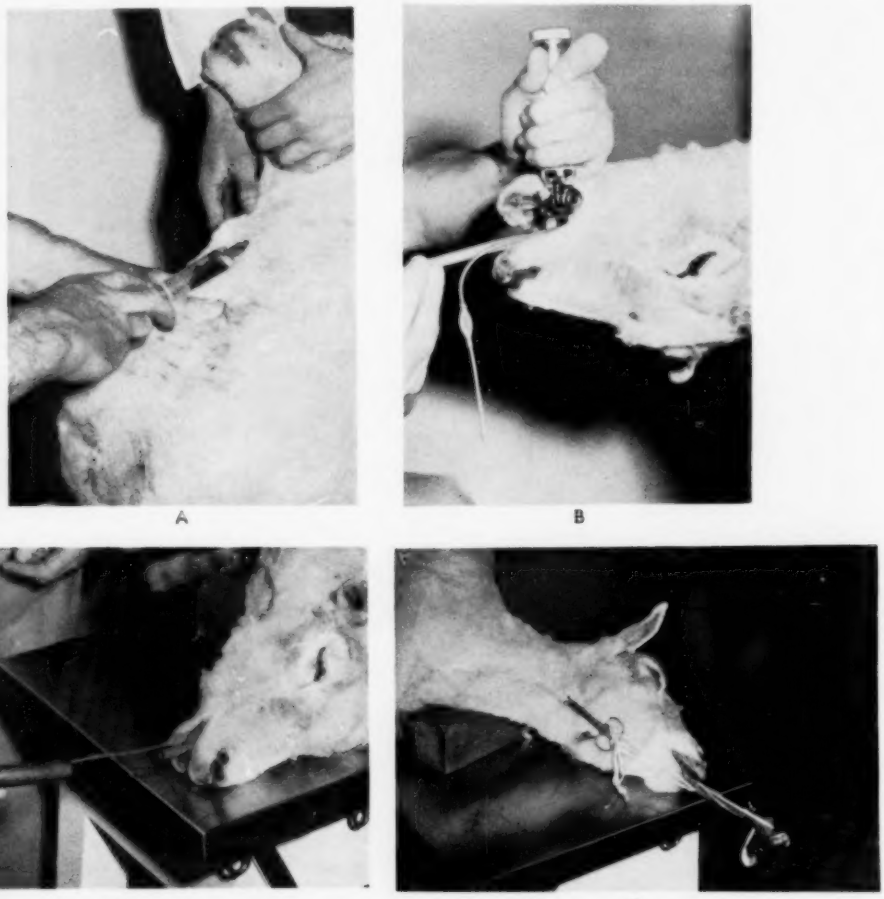


FIG. 430.—A, Injection of anæsthetic agent into the external jugular vein. B, Inserting the endotracheal tube with a Magill laryngoscope. C, Placing the copper sheath over the endotracheal tube. D, The animal anæsthetized and ready for right thoracotomy. The cuff of the endotracheal tube is inflated, and the tapes of the copper protective sheath are tied to a towel clip on the neck and to the Y-connexion carrying the hose pipes.

The metal sheath has four long tapes attached to it. A towel clip is placed in the neck and two of the metal sheath tapes are tied to this. The other two are tied to the Y-piece of the tube of the Palmer pump (*Fig.* 430 D). This ensures that the animal's head can be turned from side to side without the endotracheal tube slipping out. The whole may then be suspended by a light chain or cord from the ceiling.

a ratchet the head can be temporarily *raised*, as when working at the root of the aorta or in the upper abdomen, or *lowered*, as is most customarily used to ensure postural drainage throughout most operations. It can also be used level. Specifications are shown in the legend to *Fig.* 431. The metal hooks for the tapes holding the four limbs are placed under the table rather than at the sides. There is a stainless

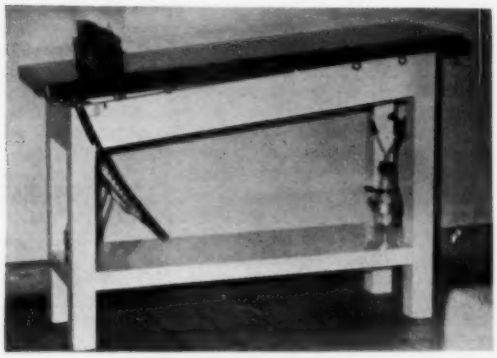


FIG. 431.—The operating table. Dimensions: Top, 51 in. × 18 in. Height, 36 in. at foot, 31 in. at head of table with ratchet lowered.

FIG. 432.—Standard ear punch and pliers for inserting brass ear tags.

FIG. 433.—Sheep in bath during induction of hypothermia. Note the collar for supporting the head.

Where intubation is not required anæsthesia may be induced by open ether alone dropped on to a towel, or by a pentobarbitone–open ether sequence. This proved a satisfactory induction for renal work, and also when one wished to perform differential bronchospirometry.

The Operating Table (*Fig.* 431).—

The operating table, of simple construction, was designed by us and made up by the Otago University Maintenance Department. Its advantage is that with steel top. An incorporated warming device under the original table proved to be of no value. The table also has holders for the water-seal drainage bottles and traps on the suction circuit. Standard water suction has been found entirely satisfactory.

General Operating Theatre Equipment.—The following equipment, standard in hospital theatres, has been found equally indispensable in animal work.

1. A small autoclave.
2. An automatic spin drying washing machine for the laundry.
3. Linen cupboards.
4. Cupboards for sterile bundles and drums and swabs, including sterile dental swabs ideal for blunt dissection.
5. A source of sterile water, such as a 3-gallon boiling heater.
6. An electric sterilizer.
7. Three trolleys, two for instruments, one for the anæsthetic; two stools.
8. A Mayo type of table.
9. A sluice basin and a wash basin.

In the ante-room is a cupboard for the surgical instruments and one for the drugs, and a chest of drawers for catgut, needles, blades, endoscopic instruments, record cards, notebooks, and so on. It is most important to keep an operation book and also a board and a card index on which animal operation and transference to and from the farm are recorded.

The operating-theatre floor should slope slightly and be provided with floor drainage. A wall clock with a large minute hand is useful, especially for transplantation and intracardiac work. Over the operating table it has also been found very convenient to have at least four hanging cords on which are standard switches for the electrical devices, such as the one for running the Palmer pump, and so on. A discarded operating-theatre light from the Dunedin Hospital has proved ideal in the animal operating theatre.

Marking of the Animals.—The sheep are marked on each ear by inserting at the base of the ear a stout brass tag bearing a serial number. Anything less than this has proved quite useless in any set of planned survival experiments (*Fig.* 432).

Hypothermia (Borrie and Woodruff, 1955).—In addition to the foregoing methods of anæsthesia, the sheep may be very easily cooled and rewarmed for any hypothermic experiment. After the animal has been anæsthetized and intubated in the usual manner, and with an intravenous polythene tube inserted through a wide bore needle into the external jugular vein, it is then lifted into a bath and covered with ice chips. The head is easily supported on two metal rods on which rest a broad collar of wire mesh which supports the head while the body is free to float in the water (*Fig.* 433). In general, using ice and salt mixture, an animal weighing 90–100 lb. will cool from 38° C. down to 29° C. within 1 hour. It has been found advisable to use short-acting relaxants such as suxamethonium bromide, for long-acting relaxants such as flaxedil (gallamine triethiodide) tend to maintain their effect too long and thereby delay the recovery period several hours. When the animal is cooled to 30° C., usually within 1 hour, it is lifted from the bath, rested on the edge to drain any surplus water, then placed on towels on the operating table and dried, and the experiment continued in the usual manner. The amount of drift is usually from 1 to 1½° C. The operation concluded, the animal is again placed in the bath and rewarmed with the water temperature at 47° C. It is removed when its temperature has risen to 35° C. Such a technique has proved eminently satisfactory for inserting freeze-dried homografts into the thoracic or abdominal aorta, and for direct intracardiac operations such as creating and closing interatrial septal defects.

Difficulties with Anæsthesia.—As with humans, so meticulous care with anæsthesia is required for success to be achieved. In working with sheep it has been our experience that anæsthesia is always the greatest problem, especially as no medically qualified anæsthetist is readily available.

The surgical experiment completed, there is still a period of painstaking care required before complete recovery can occur. It includes inflating the lungs by occluding the outlet valve for 4–5 revolutions, as well as continuous suction to the water seal. Oral and endotracheal suction are as important in sheep as in humans. The cuffed endotracheal tube must be protected throughout from destruction whenever the chewing reflex returns, which usually occurs before spontaneous respiration. Hence the use of the copper sheath. Spontaneous respiration can be encouraged by pinching the ear with a Kocher toothed artery forceps; but, if it does not quickly return—within a minute—the sheep must be reattached to the Palmer pump for a further period.

If vomiting occurs the head must be lowered, and vomitus aspirated from the mouth and nostrils. As with human beings, vomiting can occur when the sheep has left the operating room. It is as well to have the beast lying in its pen with its head low and haunch high until it has fully recovered consciousness. The incidence of vomiting, however, has been reduced almost to zero by observing the forty-eight hours of pre-operative starvation.

If bleeding has occurred during the operation, then autotransfusion can be life-saving, the blood being given through an intravenous drip into the external jugular veins.

Lung fistulæ occurred in our earlier series of experiments and were due to too great a tidal air being forced into the lungs, without the use of an adequate safety valve. On one occasion, with the pleural cavity open, the visceral pleura suddenly parted company with the lung, and stripped itself free to form a huge tension air cyst which finally burst. On another occasion it was due to kinking of the exit tube, very early in the operation, and caused fatal tension pneumothorax. As in humans, any fistula requires continuous water-seal drainage with suction.

OPERATIVE TECHNIQUE

Skin Preparation.—The skin has been prepared by cleansing with cetavlon detergent, followed by a rinse with 70 per cent alcohol. Secretions of lanolin in the axillæ and groins are removed with a fat solvent such as ether.

A. Thoracic Approaches.—In general, for thoracic surgery, approaches are made either by a vertical or transverse sternal splitting incision or by a lateral intercostal thoracotomy.

For cardiac work, in the initial experiments designed to create and close atrial septal defects by an extracardiac approach, a midline vertical sternal splitting incision gave excellent approach to both right and left sides of the heart, the edge of the pericardium incision being lifted by stay sutures

(Borrie, 1955 a). This same approach was used for dissecting the origin of the right coronary artery when placing a circumferential suture proximal to the coronary arteries (Borrie, 1957 a). In this particular group of experiments the head of the operating table was raised to facilitate dissection of the right coronary artery.

A standard *right thoracotomy* incision has been used in earlier and also in recent experiments for creating and closing atrial septal defects by intracardiac methods under hypothermia.

In the sheep's heart the ventricles readily fibrillate under hypothermia when the circulation is arrested. When protected, however, by prostigmine 1·5 mg. in 10 ml. of saline injected proximal to the aortic clamp, one can rely on 6 minutes of total occlusion of circulation without ventricular fibrillation, and with total recovery the rule. Throughout the period of circulatory occlusion the ventricles then have a slow, strong beat.

A standard left thoracotomy incision was used for operations designed to place a circumferential suture around the A.V. ring as a means of devising an adequate method for treating mitral regurgitation due to an enlarged A.V. ring (Borrie, 1954, 1955 b). In the earlier set of experiments, when this was placed around the ring *below* the left coronary artery, coronary infarction and fatal ventricular fibrillation occurred. When, however, the suture was placed between the left coronary artery and the coronary sinus, and therefore anatomically sited at the base of the valve, no such infarct occurred, and all animals recovered.

A similar left thoracotomy was used for testing freeze-dried grafts in the thoracic aorta and Hufnagel valves in the thoracic aorta. There is a good length of aorta easy of access immediately distal to the origin of the anterior aortic branch, and this is excellent for experimental purposes. It is also an excellent site for placing a constricting suture around the aorta for the experimental creating of coarctation in lambs.

Left thoracotomy has also been the approach for a recent series of experiments on pulmonary excision and re-implantation (Borrie, Campbell, and Fulton, 1958; Borrie and Fulton, 1958; Borrie and Montgomerie, 1958 a, b). The left lung was particularly chosen for these experiments as the right lung not infrequently has an upper lobe branch arising directly from the trachea. The left lung can then easily be excised by dissecting the left main bronchus, which is clamped, and divided, dissecting the pulmonary artery, which is divided between clamps, followed by bronchial artery division and ligation, and division of the inferior pulmonary ligament. Thereafter, both pulmonary veins are lifted up and a toothed bronchus clamp placed to include a cuff of the left atrial wall. The lung is then totally removed. The opening into the left atrium is closed with two layers of double No. 4 silk sutures on a No. 11 curved, round-bodied needle. In the process of re-implantation the pulmonary veins on the atrial cuff are first inserted into the atrial appendage, followed by anastomosis of the pulmonary artery after the method of Blalock, and a similar anastomosis for the left main bronchus with final fascial cuff.

In this series of operations on pulmonary excision and re-implantation, all endotracheal manipulations were done through a standard tracheotomy. They included pre-operative differential bronchospirometry, pertracheotomy intubation with a cuffed Magill endotracheal tube, endotracheal suction, post-operative toilet, including inspection bronchoscopy,

FIG. 434.—Tracheotomy tube in position 10 days after division and resuture of left main bronchus. It proved excellent for treating sputum retention.

and post-operative differential bronchospirometry. The tracheotomy could then either be closed with interrupted catgut sutures or left open and with a tracheotomy tube in place (*Fig.* 434).

Anatomical Peculiarities.—

In the chest: The vascular system of the sheep is interesting. The aortic arch gives off one large artery, an anterior aorta which divides into two subclavian vessels, and two common carotid arteries. This peculiarity ensured that clamping of the thoracic aorta beyond the origin of this branch, even for a short time at normal temperatures, resulted in permanent paraplegia. This also obtained below the renal arteries. Because of this peculiarity, therefore, when testing aortic grafts on the thoracic aorta, and the effect of inserting Hufnagel valves, it was found that the use of hypothermia was imperative for success.

The second anatomical peculiarity in most of the sheep used was a left hemiazygos vein, embryologically the remains of the left posterior cardinal vein, which passes around the root of the left lung, penetrates the pericardium, and terminates in the coronary sinus. On two occasions this has been joined by a persisting left superior vena cava and without any right superior vena cava. In experiments on creating and closing atrial defects by direct vision under hypothermia, this vein was ligated a fortnight before operation by a small left thoracotomy. Such an operation was ably undertaken by

surgical technicians. It thereby ensured that no excess flow of blood occurred through the coronary sinus during the period of circulatory arrest. In any operative re-assessment of Beck II operations, therefore, the sheep should prove an ideal subject, for it already has a large vein entering the coronary sinus, and one which already courses over the aorta at a place where it is long, easily mobilized, ready for aortic anastomosis.

B. Abdominal Approaches.—*A midline laparotomy incision* has been used in pregnant ewes in approaching the uterus to carry out intra-embryonic injections of foreign spleen cells in an attempt to induce tolerance for subsequent work on homotransplantation (Mitchell, 1959 a). Mammary veins which are large during pregnancy are found on either side of the midline in the lower abdomen and must be avoided. Careful closure with interrupted sutures was essential, for if continuous sutures alone were used the incision showed a tendency to develop an incisional hernia.

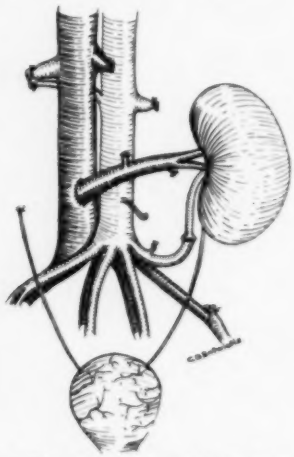


FIG. 435.—Diagram of a left iliac kidney autotransplant.

Paramedian laparotomy incisions have been used for intraperitoneal iliac transplantation of the kidney (Mitchell, 1957). When using this approach it was found advisable to split the rectus abdominis muscle as the posterior rectus sheath is a very thin structure and does not suture well when the rectus muscle has been displaced.

Oblique and transverse loin incisions have been used extensively in the approach to the kidneys. These incisions heal well and the peritoneum may be readily stripped medially to expose the great vessels. With the sheep lying on its opposite side, the bulky stomach falls away and can be displaced readily from the area of operation. This extraperitoneal approach has been used for operations involving local renal hypothermia, renal ischæmia, and renal homotransplantation (Mitchell, 1959 b; Mitchell and Woodruff, 1957 a, b). In sheep the external iliac artery on one side can be divided without evidence of circulatory disturbance in the limb, and this has allowed the use of this artery for end-to-end anastomosis to the renal artery in kidney transplantation procedures (*Fig.* 435). The cut iliac vein is, however, too small for anastomosis to the renal vein so that end-to-end anastomosis of the latter to the inferior vena cava has been used.

Anatomical Peculiarities.—

In the abdomen: The alimentary tract of the sheep is peculiar in several ways. Firstly, the stomach is an extremely large organ in three sections and encumbers transperitoneal operations. Normally there is considerable gaseous distension from fermentation and this usually proves difficult to empty by a wide bore stomach tube, because of the nature of the gastric contents. The small intestine is extremely thin in the wall and narrow in diameter, necessitating great care in suturing any peritoneal incisions to avoid herniation and strangulation of bowel. As in other herbivorous animals, the appendix of the sheep is long. The great vessels in the abdomen are similar to the human anatomy. The terminal aorta in the sheep frequently gives off two external iliac arteries, leaving a short terminal aorta below, which bifurcates into the internal iliac arteries, leaving a median sacral artery. In some animals the internal and external arteries arise together, the aorta breaking up into four arteries (*Fig.* 436). There is a fairly large median sacral artery continuing down into the region of the tail.

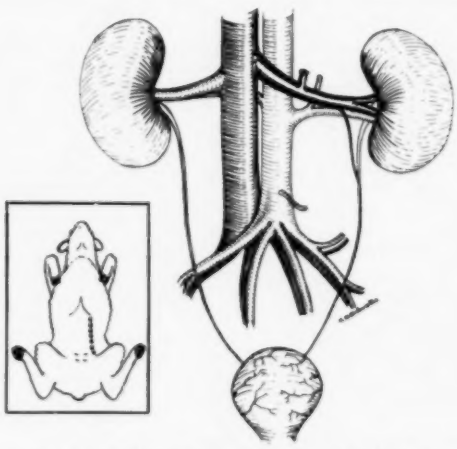


FIG. 436.—Diagram of normal anatomy of terminal aorta and urinary tract of the sheep. Inset shows site of paramedian incision for intra-abdominal kidney transplantation.

The abdominal aorta is easily accessible for arteriography or experimental vascular surgery, but occlusion of the aorta below the renal arteries at normal body temperatures for more than 15 minutes is always accompanied by paraplegia of the hind legs due to anoxia of the lumbar cord.

The kidneys of the sheep are unilobular with a very small renal pelvis of the intrarenal type, rendering intravenous pyelography impractical. The renal vessels conform to human anatomy except that the left kidney hangs ventrally from its vessels suspended

in a covering of perinephric fat. This fact accounts for the lengthy left renal vessels and makes operations on the left kidney extremely easy technically, and also facilitates the use of this kidney in grafting operations.

Surgical Retraction.—For thoracic operations an Edwards's modification of the Finochetto thoracic ratchet retractor has proved excellent, and far sturdier than the Tudor Edwards's 4-blade retractor. For abdominal work large towels and wide blade Deaver retractors are necessary. The Jenkins's modification of the Devine retractor is extremely useful, and dispenses with one assistant (*Fig.* 437).

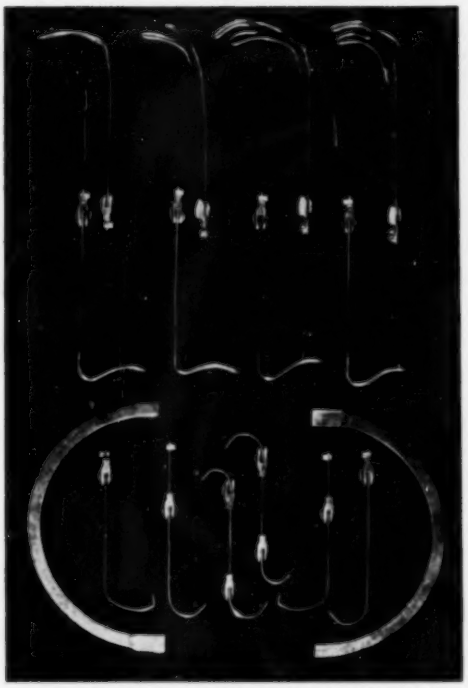


FIG. 437.—The Jenkins retractor. A wide variety of self-retaining blades fits on to the large circular band.

WOUND CLOSURE

For the thoracic cavity the standard methods of closure over water-seal drainage are required. Interrupted chromic catgut sutures are excellent for all deep layers, and either interrupted or continuous catgut for the skin. Similarly, abdominal incisions in sheep are best sewn with absorbable interrupted sutures, using a running catgut stitch to close the peritoneum and a running catgut stitch to close the skin, thus avoiding the necessity of removing skin stitches. Both thoracic and abdominal wounds heal well in a matter of a week. In pregnant animals, however, unless care is exercised, lower abdominal incisions may be complicated by an incisional hernia. The use of non-absorbable sutures is contra-indicated, especially where the animal is later to be marketed.

C. Cervical Operations.—

Peripheral Arteries.—Regarding the testing of freeze-dried peripheral arteries, the common carotid artery proved relatively satisfactory, but it was shown that with all peripheral arteries of small calibre, any freeze-dried grafts, no matter how carefully the anastomosis was placed, almost invariably thrombosed, and usually at the proximal end.

D. Trachea.—The trachea of the sheep was successfully used for a series of experiments designed to show the effect of excising one, two, or three rings of the trachea in lambs and to note whether or not stenosis developed as the animal grew (Borrie, 1957 b). In addition, the effect was observed of bridging the gap with tantalum mesh or polyvinyl sponge.

POST-OPERATIVE CARE

The operation over, check that:—

1. The water-seal drain is satisfactory.
2. All air has been expelled from the pleural cavity.
3. The animal is not biting the endotracheal tube.
4. The mouth and trachea are sucked free from mucus.
5. Any blood loss has been made good.

FIG. 438.—A sheep requiring continuous pleural suction, resting on a Cyclone ewe holder.

Water-seal Drainage.—Where, because of a persistent air leak from the lung, prolonged intercostal water-seal drainage with suction is necessary, this presents no difficulty, for the animal is easily supported on a Cyclone ewe holder, and can remain there for 12–24 hours if necessary (*Fig.* 438).

Tracheal Toilet.—Whenever endotracheal tubes have been used, careful suction cleansing is required before extubation. In the same way excess secretion in the mouth should be sucked clear. Finally, the animal is returned to the pen and placed on its side so that its hips are higher than its head, which is easily done by resting them on a mound of straw.

Chemotherapy.—Following operation the animals receive crystomycin, 1 ampoule per day for 5 days. If anticoagulants are required, the post-operative maintenance dose of dindevan 100 mg. is given per day.

Tracheotomy.—If a tracheotomy tube has been used it requires the standard toilet at least thrice daily. The largest size tracheotomy tube possible should be used (*see Fig.* 434).

Regarding Killing.—The wool is marketed, but not the sheep, as wages for butchering exceed receipts from the sale of meat, and because technicians' time is required for other experimental duties. An intravenous injection of nembutal plus relaxant is therefore the quickest and kindest method of killing animals at the end of a series of experiments.

LUNG FUNCTION IN THE SHEEP

Bronchospirometry in the Sheep (Borrie and Montgomerie, 1958 b).—Differential bronchospirometry has been found necessary during operations designed to remove and re-implant a lung; for example, in evolving techniques for lung transplantation and also by this means obtaining total lung denervation for physiologic studies on the nature of breathing. In these circumstances it has been an advantage to use standard Carlens tubes, standard bronchoscopes, and a Palmer twin recording spirometer. This has been possible by inducing anæsthesia with pentobarbitone and open ether, and thereafter performing tracheotomy. Through this tracheotomy a No. 39 Carlens double lumen catheter is inserted, the pilot cuffs inflated, the ends connected to the spirometer, and oxygen uptake per lung per minute recorded.

This is at the same rate as in man, an average reading being 150 ml. per minute per lung oxygen uptake. The reading completed, the Carlens tube is removed, a cuffed endotracheal tube inserted through the tracheotomy, and the operation performed. When it is concluded the tube is removed, the animal bronchoscoped, the Carlens tube reinserted, and a post-operative reading taken. When this is completed, the tube is again removed, and either a tracheotomy tube left in situ if required for post-operative endotracheal toilet, or alternatively the tracheotomy is soundly closed with interrupted silk sutures. No strictures resulted at the tracheotomy site.

URINARY FUNCTION IN THE SHEEP

In male animals urine can be collected with a plastic box strapped to the abdomen (*Fig.* 439). In female animals an indwelling Malecot catheter may be inserted through the urethra. This is rather difficult and requires anæsthesia with retraction of the posterior vaginal wall with a small Langenbeck retractor.

Under natural conditions the urine production of sheep is governed by a relatively small fluid intake. Under drought or laboratory conditions where dry grass and hay form the bulk diet the animals drink water freely. Under such conditions total urine output averages 300–500 ml. per 24 hours, but figures much lower than this are frequent. The specific gravity is high, approximately 1020–1040, and the urea concentration is approximately 3–4 g. per 100 ml. as measured by the micro-Kjeldahl method. The sodium and potassium concentrations in sheep urine show a wide range of variation. Its natural diet results in a high potassium intake and the sheep kidney possesses the ability to reverse completely the sodium-potassium ratio of the serum in order to maintain adequate excretion of potassium. The sodium concentration in mEq./l. ranges from 2 to 70 and the potassium ratio varies from 20 to 200 mEq./l. The serum electrolytes in sheep correspond to the value in human beings, serum sodium averaging 140–145 mEq./l. and the serum potassium 4·5–5 mEq./l.

Cystoscopy is relatively easy in the female sheep but impossible in the male animal. In the former a Wolff catheterizing cystoscope approximately 14 French in diameter will negotiate the urethra. There is a valvular fold towards the anterior wall of the urethra which if roughly negotiated results in the formation of a false passage. With 150 ml. of lotion distending the bladder good visualization of the ureteric orifices is obtained. They lie close together on the posterior wall without much evidence of a trigone or inter-ureteric bar. Both ureteric orifices can be visualized in the one cystoscopic field. Indigo-carmine excretion is prompt with good concentration in 2½ minutes using 4 ml. of 0·4 per cent solution intravenously, and such a test gives a reasonable assessment of the excretory function of grafted kidneys. Catheterization of either ureter is easy, but the ureteric orifice is small, necessitating the use of a fine ureteric catheter approximately 4 French.

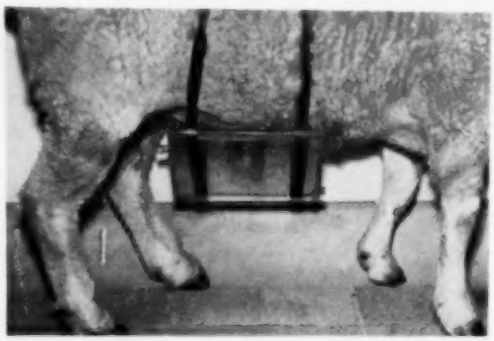


FIG. 439.—The plastic box for urine collection in sheep. The box is triangular in cross-section with an inkwell fitting (as shown) for the penis in male sheep. In female sheep an indwelling catheter is connected from the urethra behind, and passes forward between the hind legs to an intake nipple at the top of the posterior wall of the box.

Abdominal aortography by the open or closed techniques is comparatively easy when carried out with the animal lying on its right side. As a test of renal function this is a satisfactory method in the sheep.

SUMMARY

The use of the sheep as an experimental animal in surgical science is described. Emphasis is placed on pre-operative care, anæsthesia. and post-operative care in experiments designed to establish methods for correcting atrial septal defects and mitral regurgitation, as well as in work on division and resuture of the trachea, and the inserting of freeze-dried arterial homografts into the carotid arteries and into the thoracic aorta under hypothermic conditions. Sheep have also been used for placing circumferential sutures around the origin of the aorta below the coronary arteries, as well as in major studies on pulmonary re-implantation and renal transplantation.

In addition, certain anatomical peculiarities are indicated, as well as methods for assessing lung and renal function.

Acknowledgements.—It is a pleasure to acknowledge initial encouragement from the Dean of the Medical School, Sir Charles Hercus, from Mr. W. Hall, Head of the Animal Department, from Dr. F. Fastier, Department of Pharmacology, and from Mr. George Holmes, Director of Invermay Research Farm, New Zealand Department of Agriculture. We also thank Messrs. Fraser Aitken, John Walsh, John Flawn, and Les Cantwell, all of whom in turn have provided painstaking technical assistance, and Miss Catherine Entwistle, Medical Artist, and Messrs. Gerald Brook and Graham Cook of the Photographic Unit of the Otago Medical School, for the illustrations. Finally, we are grateful for financial support from the University of Otago and also from the Medical Research Council of New Zealand.

REFERENCES

BORRIE, J. (1953), *Proc. Univ. Otago med. Sch.*, **31**, 31.
— — (1954), *Ibid.*, **32**, 24.
— — (1955 a), *J. thorac. Surg.*, **29**, 426.
— — (1955 b), *Ibid.*, **30**, 687.
— — (1957 a), *Proc. Univ. Otago med. Sch.*, **35**, 6.
— — (1957 b), *Ibid.*, **35**, 15.
— — CAMPBELL, G. D., and FULTON, I. B. (1958), *Ibid.*, **36**, 31.
— — and FULTON, I. B. (1958), *Ibid.*, **36**, 32.
— — and MONTGOMERIE, J. Z. (1958 a), *Ibid.*, **36**, 9.
— — — — (1958 b), *Ibid.*, **36**, 10.
— — and WOODRUFF, M. F. A. (1955), *Ibid.*, **33**, 33.
MITCHELL, R. M. (1957), *Ibid.*, **35**, 11.
— — (1959 a), *Transplant. Bull.*, **6**, 424.
— — (1959 b), *Aust. N.Z. J. Surg.*, **28**, 263.
— — and WOODRUFF, M. F. A. (1957 a), *Proc. Univ. Otago med. Sch.*, **35**, 12.
— — — — (1957 b), *Transplant. Bull.*, **4**, 15.

SHORT NOTES OF RARE OR OBSCURE CASES

CÆCAL INFARCTION WITH FALSE APPENDIX

BY J. S. G. BLAIR
SENIOR SURGICAL REGISTRAR
AND HELEN L. D. DUGUID
DEPARTMENT OF PATHOLOGY, MARYFIELD HOSPITAL, DUNDEE

INFARCTION of the cæcum alone is extremely uncommon and we have found no case described in English in the literature of this century. The following case of local cæcal infarction had a false appendix as an unusual incidental finding.

CASE REPORT

The patient was aged 30 years and had been in a mental hospital for eight years with feeble-mindedness and added schizophrenia. Being inert and apathetic for long periods he had to be fed, but his capacity was enormous, and he would eat paper if the opportunity arose. One month before his death he began a course of chlorpromazine, in a dosage rising to 300 mg. daily, and this resulted in a distinct improvement in his mental state. He had more to say, and even got up for several hours each day. When his mother visited him she used to give him large amounts to eat, and it was quite common for a vomiting attack to follow one of her visits. He vomited twice nine days before his death, as usual after a visiting day, but one week later he vomited once again, and again the next day. Now, however, he looked very ill, and complained of abdominal pain; there was guarding in the right lower quadrant of his abdomen but no rigidity, and bowel-sounds were heard. He was thought to have acute obstructive appendicitis with perforation and peritonitis, but died before this could be confirmed by laparotomy.

At necropsy the stomach was very large, but showed no other abnormality. The cæcum lay in its normal position, but was black, enormously distended, and filled with gas and grumous pink-coloured material. The pelvis contained dark serosanguineous fluid, and there was a fibrinopurulent exudate on the serous surface of the pelvic colon and nearby small bowel. The lesion extended from the cæcum to involve 10 cm. of terminal ileum and 4 cm. of proximal colon, each junction with normal bowel being quite sharp. The appendix was discoloured, but much less than the cæcum, and showed no sign of inflammation. The cæcal wall showed a thickened, wedge-shaped area of hæmorrhagic infiltration involving its anterior, medial, and posterior aspects, but the rest of the infarcted bowel was thin and friable (*Fig.* 440). There was no evidence of mucosal ulceration or perforation and the peritonitis was considered to be secondary to the bowel necrosis.

Dissection of the specimen showed widespread venous thrombosis, the anterior and posterior cæcal veins being thrombosed throughout their naked-eye extent and widely dilated to a maximum diameter of 0·6 cm. The thrombosis extended beyond their junction for 1 cm. along the superior mesenteric vein. Within the mesentery beyond the edge of the bowel the vein narrowed suddenly, but still contained clot. The superior mesenteric artery also contained clot at this point, but nowhere else.

Microscopic examination showed no evidence of appendicitis or of arterial or venous disease. In the cæcum there was necrosis of the whole thickness of the wall, with hæmorrhagic infiltration into the pericæcal tissues and a fibrinopurulent exudate covering the peritoneal surface. Sections from the affected areas of ileum and colon showed necrosis involving the mucosa alone, the muscle coat being intact.

A false appendix was present arising from the posterior tænia coli just above the junction of the cæcum and ascending colon, and measured 10 cm. in length and

0·6 cm. in diameter. It was made up of angiomatous fatty and fibrous tissue covered by peritoneum.

DISCUSSION

The false appendix was probably an abnormal appendix epiploica, similar to that described by Latimer and Kinshaw (1947). It could well have been removed mistakenly, however, for it presented more obviously on first examination of the cæcum than the true appendix. Leonardo (1943), in a review of the literature, found 36 cases of true double appendix and added 2 of his own, one lying in the meso-appendix, which he considered genuine, the other arising from the anterolateral wall of the cæcum, which he thought probably a cæcal diverticulum. Duplication of the appendix is, in any event, extremely rare. Collins (1955), in his paper describing 50,000 specimens of the vermiform appendix, found two instances only of true congenital duplication (0·004 per cent) and only one of pseudoduplication.

The important pathological lesion was the local infarction of the cæcum, and we consider that this followed thrombosis of the cæcal veins. Venous thrombosis during chlorpromazine therapy has been described (Fernandes and Leitro, 1956; quoted by May & Baker, 1959), but hypotension, vasodilatation, and subsequent cæcal thrombosis seem an unlikely sequence here. The sudden narrowing of the superior mesenteric vein just beyond the edge of the bowel may give a clue to the aetiology, for it may have been the site of a local kink or twist, and the wide dilatation of the distal veins also suggests that local obstruction to venous return could well have initiated the thrombosis. There is no doubt that the cæcum is often a very mobile organ, and we suggest a partial and self-reducing volvulus as the cause of local vascular obstruction and so of cæcal infarction and necrosis. While volvulus of the cæcum is a rare condition in this country, it is not uncommon amongst vegetarian and maize-eating peoples, whose intestinal contents remain very bulky (Baneri, 1951; Pool and Dunavant, 1951; quoted by Aird, 1957). In our case greed and paper-eating habits may well have been contributory by producing episodes of cæcal over-distension.

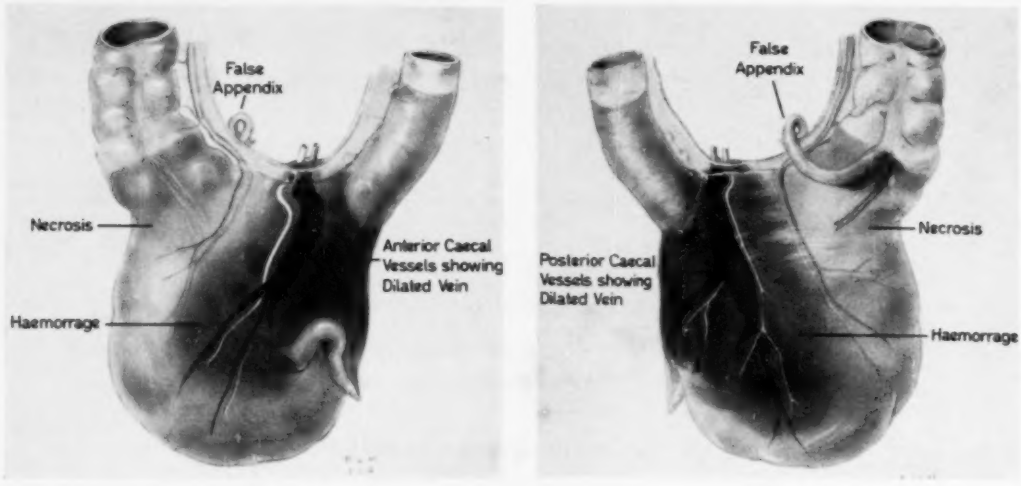


FIG. 440.—View of cæcum showing A, Anterior, and B, Posterior aspects of the areas of necrosis and hæmorrhage, and the dilated anterior cæcal vein.

Petacci (1938) reported 2 cases of hæmorrhagic infarction of the cæcum due to primary thrombosis of the vessels supplying it, the one occurring in a boy aged 9 years, the other in a man of 27 years. Both were admitted with a diagnosis of acute appendicitis, but at laparotomy the appendix was normal and the cæcum infarcted. Both were treated successfully by right hemicolectomy. Histological examination of the cæcum of the little boy showed necrosis affecting the mucosa and the inner part of the muscle coat. The vessels in the cæcal wall were angiectatic and were described as having a "pseudo-cavernous appearance". The cæcum of the young man was completely infarcted, with ulceration of the mucous membrane and thrombosis in the small vessels. Petacci suggested that the infarction in his two cases depended upon some anatomical abnormality in the cæcal blood-supply, but could not say what caused the thrombosis.

Vascular lesions in the lower gastro-intestinal tract have been discussed recently as a cause of unexplained bleeding and also in relation to ulcerative colitis (Warren and Sommers, 1949), but greatest interest in the blood-supply to the cæcum and the occurrence of infarction there has been in South America, where Pierini (1940) described a case of infarction involving the cæcum and proximal ascending colon. His case, and that of Suarez (1945), were concerned with the association of the cæcal branch of the appendicular artery and cæcal necrosis; Suarez's case of cæcal necrosis did, in fact, follow

appendicectomy. Pierini considered that the blood-supply to the anterior wall of the cæcum depended upon anastomoses from the basal part of the appendicular artery, which at appendicectomy should therefore be tied as far distally as possible. The cæcum is supplied by the terminal anterior and posterior cæcal branches of the ileocolic artery. In the small gut the terminal branches of the superior mesenteric artery anastomose freely, but it is known that the blood-supply to the large bowel and to the cæcum in particular is less luxurious, and, indeed, anatomists have gone so far as to describe the small cæcal vessels as *end-arteries*, emphasizing their lack of anastomosis with adjacent vessels in the ileum and ascending colon (Testut, 1902; Taylor, 1904; Morris and Johnson, 1925; Riviero, 1941; quoted by Martinez Carreras, 1953). Ross (1950) stressed the imperfect anastomosis of the vasa recta in the large gut at the antimesocolic border, thus rendering the colon unable to withstand distension and being a factor in the occurrence of 'stercoral ulcers' associated with colonic obstruction. He also noted that the cæcum in particular is avascular. However, Carreras (1953) injected specimens of the cæcum, terminal ileum, and appendix and described a free network of vessels in the cæcal wall, refuting to his own satisfaction the idea of end-arteries there. The question therefore does not appear to be by any means settled, and it is possible that vascular abnormalities in part or even the whole of the large bowel may account for a precarious collateral blood-supply in certain persons who are thus especially liable to colonic infarcts (Trotter, 1913; Thomson, 1949).

SUMMARY

A case of local cæcal infarction is described, with a false appendix as an usual incidental finding. A self-reducing volvulus of the cæcum is suggested as the possible cause. Anatomical descriptions of the blood-supply to the large bowel in general, and to the cæcum in particular, suggest that in certain persons the collateral circulation may be deficient.

We wish to thank Dr. George Smith for his advice and criticism, Mr. Douglas J. Gifford, Department of Spanish, University of St. Andrews, for his help, and Miss Margaret Mackenzie, Medical Artist, University of St. Andrews, for her drawing of the specimen.

REFERENCES

AIRD, I. (1957), *A Companion in Surgical Studies*, 2nd ed. Edinburgh: E. & S. Livingstone.
BANERI, J. (1951), quoted by AIRD (1957).
COLLINS, D. C. (1955), *Surg. Gynec. Obstet.*, **101**, 437.
FERNANDES, B., and LEITAO, G. (1956), quoted by MAY & BAKER. Personal communication (1959).
LATIMER, H. B., and KINSHAW, A. H. (1947), *J. Kans. med. Soc.*, **48**, 112.
LEONARDO, R. M. (1943), *J. int. Coll. Surg.*, **6**, 64.
MARTINEZ CARRERAS, A. (1953), *Prensa méd. argent.*, **40**, 268.
MAY & BAKER LTD. (1956), *Pharmacology of Largactil*.
MORRIS, and JOHNSON (1925), quoted by CARRERAS (1953).
PETACCI, M. (1938), *Minerva med., Roma*, **2**, 448.
PIERINI, A. (1940), *Rev. Asoc. méd. argent.*, **54**, 737.
POOL, R. M., and DUNAVANT, W. D. (1951), quoted by AIRD (1957).
RIVIERO, T. (1941), quoted by CARRERAS (1953).
ROSS, J. A. (1950), *Edinb. med. J.*, **57**, 572.
SUAREZ, A. ROQUE (1945), *Bol. Soc. cir. Córdoba*, **6**, 156.
TAYLOR, J. W. (1904), quoted by CARRERAS (1953).
TESTUT, L. (1902), quoted by CARRERAS (1953).
THOMSON, F. B. (1949), *Canad. med. Ass. J.*, **58**, 183.
TROTTER, L. B. C. (1913), *Embolism and Thrombosis of the Mesenteric Vessels*. London: Cambridge University Press.
WARREN, S., and SOMMERS, S. C. (1949), *Amer. J. Path.*, **25**, 657.

A LARGE THYROGLOSSAL CYST

BY GEOFFREY KEYNES, LONDON

THYROGLOSSAL cysts are common, but they do not often increase untreated to the size of the example recorded here.

CASE REPORT

A baker aged 48 years, of somewhat limited intelligence, was admitted on Oct. 19, 1954, to New End Hospital, Hampstead (from the care of Dr. R. P. Gillespie of Peterborough). He complained of an enormous swelling in the neck, somewhat larger on the right side than on the left. This had been slowly increasing over about twenty years until it was of approximately the same size as his head (*Fig.* 441). His voice had become much altered during the past four years, being now very hoarse, with indistinct articulation, but he had not complained of any other symptoms. He had no dyspnœa, orthopnœa, or dysphagia. He regarded himself as a fit man apart from the disfigurement due to the conspicuous swelling.

When examined in hospital, the swelling was found to be obscurely fluctuant, and the skin over parts of it was reddened and hot, though there was no fever. There was extreme displacement of the trachea to the left and the larynx could not be identified. The right carotid artery was displaced backwards so as to lie in a plane nearly 1 in. behind the ear (*Fig.* 441).

The patient had been presented as suffering from a 'goitre', though he was euthyroid. When examined (by Mr. N. Asherson in the Throat Department), the patient was found to have a large mass protruding into the right side of the oropharynx, and the base of the tongue was much raised. No view of the epiglottis or larynx could be obtained. The diagnosis was in doubt until a lateral radiograph showed that the hyoid bone and the larynx were separated by an interval of 5 in., the larynx being situated behind the mesial half of the left clavicle. 'Thyroglossal cyst' then seemed to be the only possible diagnosis.

Aspiration of several ounces of typical cyst fluid helped to confirm the diagnosis and to relieve the pressure on the tightly stretched skin. Operation was undertaken on the following day, a somewhat difficult problem being presented to the anæsthetist (Dr. John Ord). Introduction of an endotracheal tube through the mouth was out of the question, but it was hoped that the relief of pressure given

by the previous aspiration might allow a reasonable airway. Immediately after the induction of anæsthesia, however, breathing became completely obstructed, and a hasty laryngotomy had to be performed. The trachea was quite inaccessible, and even the cricothyroid membrane was situated deeply behind the left clavicle, so that laryngotomy was difficult; but this was accomplished by pulling the larynx upwards with a hook, and the introduction of an endotracheal tube through the opening allowed the operation to proceed.

The skin was divided by a horizontal incision over the centre of the mass and flaps were dissected above and below. The whole cyst was then dissected away from the hypopharynx, the mucous membrane of the mouth, the hypoglossal muscles, and the suprasternal fascia and from its attachment to the hyoid bone. A large calcified plaque

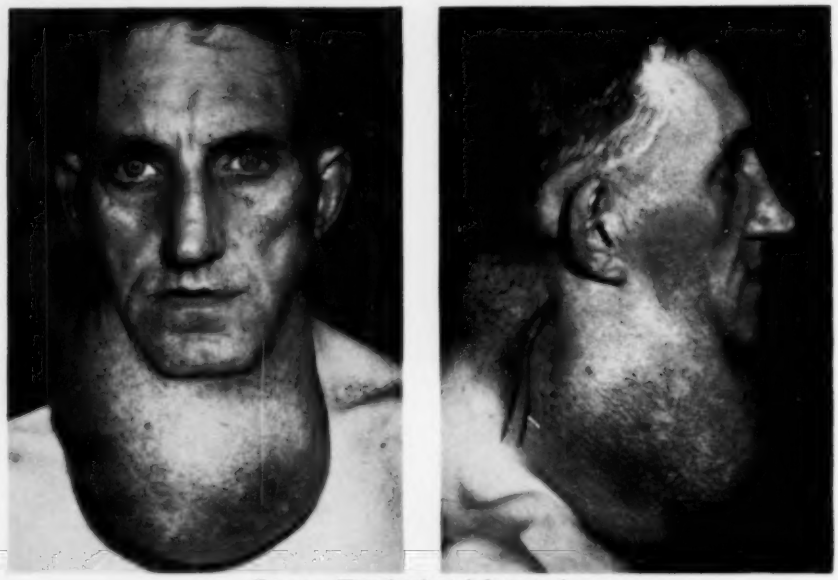


FIG. 441.—Thyroglossal cyst before operation.

FIG. 442.—Thyroglossal cyst after operation.

protected much of the hypopharynx, and only one small perforation was made, this being easily oversewn. The right recurrent laryngeal nerve was exposed. The wound was drained on each side and a laryngotomy tube was left in position. The tube was removed twenty-four hours later, and the patient was then able to breathe comfortably. Convalescence was uneventful. The trachea returned at once to the middle of the neck, but the separation of the hyoid from the larynx remained. The patient was discharged from hospital three weeks after the operation with an improved voice and, except for some redundant folds of the skin of the neck (*Fig.* 442), a greatly improved appearance.

The diagnosis of thyroglossal cyst was confirmed by microscopic section of the wall.

The patient was seen eighteen months later and, apart from still having a somewhat gruff voice, seemed to be normal and in good health.

CYST OF THE TRIANGULAR INTRA-ARTICULAR CARTILAGE OF THE WRIST-JOINT

By V. H. WHEBLE

FROM THE MANFIELD ORTHOPÆDIC HOSPITAL, NORTHAMPTON

In 1958 Berbayer described a case of cyst formation in the intra-articular disk, or fibrocartilage, of the acromioclavicular joint, and stated that: "Except in the knee, cyst formation associated with an intra-articular disk must be quite rare, for a review of the literature does not reveal any record of such a condition."

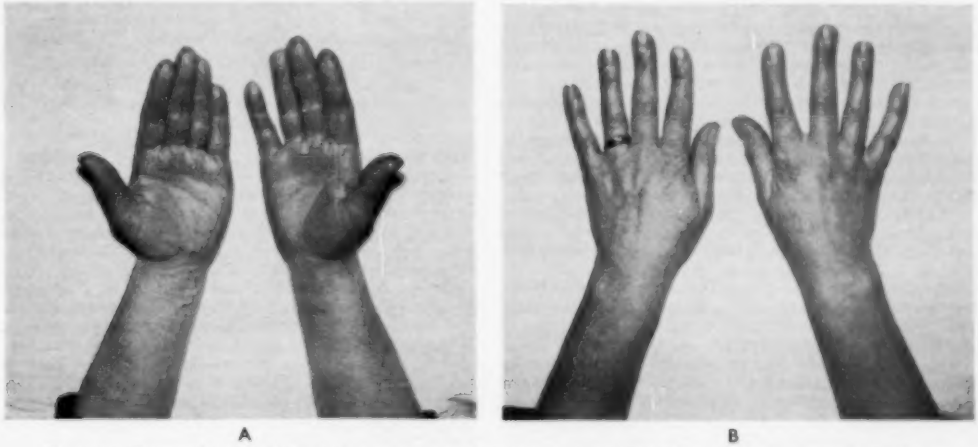
A further search since Berbayer's paper was published has failed to show any subsequent publication of a similar case. It is therefore as a matter of interest that the following case is reported, as it also seems to be unique.

CASE REPORT

In January, 1958, a woman aged 45 years was sent to the out-patient department complaining of a pain in the region of the lower radio-ulnar joint of the right wrist, which had been present for about five months. The pain had become gradually worse, and was now interfering with her housework; there was no evidence of any type of injury preceding the onset of the condition. When

FIG. 443.—Photograph of the incision three months after the operation.

FIG. 444.—Photograph of the triangular cartilage showing the cyst in situ before sectioning.



A B

FIG. 445.—Photographs of both hands after operation to show A, the range of supination, and B, the range of pronation.

the wrist was examined it was found that the pain was located very accurately to a point on the ulnar side of the lower radio-ulnar joint; it was more severe on palmar-flexion, abduction, and circumduction of the wrist, and also when pressure was exerted on the lower end of the ulna. An X-ray examination showed no abnormality.

After a long period of physiotherapy the condition had not altered, and it was decided to explore the affected joint, as it was thought that there might be a tear of the triangular cartilage. At operation in July, 1958, the lower radio-ulnar joint was exposed through a longitudinal incision on the medial side of the wrist, centred over the lower end of the ulna (*Fig.* 443). A small cyst was found which was arising from within the triangular cartilage (*Fig.* 444). The cartilage was removed and the wound closed in layers. In ten days healing was satisfactory, and the skin sutures were removed. The patient has since made an uninterrupted recovery, and has regained full function (*Fig.* 445).

HISTOLOGICAL EXAMINATION.—When the triangular cartilage was sectioned, the swelling in its outer part was shown to be due to mucoid degeneration of the cartilage: the cyst contained a small quantity of glairy fluid resembling mucus. The lining of the cyst wall presented no unusual features, and the condition was in every way similar to the much commoner cystic degeneration of the lateral meniscus of the knee-joint.

DISCUSSION

The presence of cysts in any of the intra-articular fibrocartilages of joints, other than in the knee-joint, is surprisingly rarely recorded in the literature. There appears to be no reason why the process of degeneration in fibrocartilage which precedes the development of this type of cyst should not take place wherever these structures are present in a joint (e.g., in the wrist, the acromioclavicular, the sternoclavicular, and the temporomandibular joints, as well as the knee-joint). Cystic degeneration is commonly supposed to follow trauma to the affected joint, but although dislocations, subluxations, fractures, and sprains of these joints are all relatively common, the only recorded cases of cyst formation outside the knee-joint are in the acromioclavicular joint (Berbayer's case) and the wrist-joint (as reported here). It may be that the rarity of the condition in the joints of the upper limb is related in some way to the functional differences between it and the lower limb, or to some obscure difference in the nutrition of the fibrocartilages in the upper limb as compared with those found in the knee-joint.

SUMMARY

A case is reported of cystic degeneration in the triangular cartilage of the wrist-joint, with perfect recovery after excision of the whole cartilage. The method of production of this cyst remains obscure.

I am grateful to W. R. D. Mitchell, Esq., for permission to publish this case, and I should also like to acknowledge the kind assistance of Mr. Pamley who prepared the photographs.

REFERENCE

BERBAYER, P. (1958), *J. Bone Jt. Surg.*, **40-B**, 100.

REVIEWS AND NOTICES OF BOOKS

Textbook of British Surgery. Vol. IV. Edited by Sir HENRY SOUTTAR, C.B.E., D.M. (Oxon.), F.R.C.S., Consulting Surgeon, London Hospital; and J. C. GOLIGHER, Ch.M.(Edin.), F.R.C.S.(Edin. and Eng.), Professor of Surgery, University of Leeds. 9¾ × 7 in. Pp. 699 + viii, with 405 illustrations. 1959. London: William Heinemann Medical Books Ltd. 105s.

THIS fourth volume which is the final one of this comprehensive work on surgery is devoted for the most part to orthopaedic conditions. There are some seventeen contributors to this volume, all of whom are acknowledged experts in their own particular field. Mr. Norman Capener is the editor of this orthopædic section.

It must be acknowledged that the treatment of deformities, fractures, and traumata is an extensive branch of surgery and the editors have wisely seen that these subjects have been very adequately dealt with.

In spite of the advances made in antibiotic treatment, much space has been given to inflammation and septic conditions, for these, together with burns and injuries to the hand, still take up much of the surgeon's time.

The illustrations throughout this volume are excellent; many of them are original and they do enhance the written word. The viewpoint throughout these four volumes is essentially clinical and practical.

This modern work is a monumental achievement to British surgery. The work will prove of real worth to the young surgeon both at home and abroad, and those post-graduate students who are working for higher examinations will find the volumes of great assistance to them in their studies.

Encyclopedia of Urology.

Volume 15, **Urology in Childhood.** By D. INNES WILLIAMS. 9¾ × 6¼ in. Pp. 353 + xvi, with 162 illustrations. 1958. Berlin: Springer-Verlag. D.M.118.

Volume 9, Part 2, **Specific Inflammations.** By EINEN LJUNGGREN, R. CAMPBELL BEGG, and AMBROSE J. KING. 9¾ × 6¼ in. Pp. 564 + xvi, with 90 illustrations. 1958. Berlin: Springer-Verlag. D.M.158.

Volume 6, **Endoscopy.** By ROGER W. BARNES, R. THEODORE BERGMAN, and HENRY L. HADLEY. 9¾ × 6¼ in. Pp. 282 + xxiv, with 184 illustrations. 1959. Berlin: Springer-Verlag. D.M.136.

THE original "Handbuch" of urology published in German in 1928 in three volumes was recognized not only as a standard work but as the most complete treatise on the subject at the time; the new edition has an international basis. The advances made in urology in thirty years now demand no less than sixteen volumes to cover the specialty in the same thorough manner; 92 authors from 11 countries are contributing under four distinguished editors from Germany, Great Britain, America, and Switzerland. Despite the vast nature of the task there is the same evidence of completeness and of attention to detail as there was in the old "Handbuch". Extensive bibliographies with the title of each paper in full follow each section and there is both an author index and a subject index which make the work ideal for references Each volume is complete in itself, thus catering for those who have a specialty within a specialty. The contributions

are in English, French, or German. Three volumes have now appeared, not in numerical sequence.

Vol. 15, *Urology in Childhood*, by D. Innes Williams: It is a matter of satisfaction that the first volume to be published is by a British author; it has set a standard for the remainder which will be hard to equal and impossible to surpass. Mr. Innes Williams has given a complete account of pædiatric urology based not only on his own extensive experience but on a wide knowledge of the literature. His approach is essentially conservative, as for example in the non-operative management of megaureter. His account of the congenital abnormalities of the urinary tract is the best we have seen.

Vol. 9/2, *Specific Inflammations*: Einar Ljunggren, with the co-operation of several Swedish colleagues, has given a comprehensive account of urogenital tuberculosis. His experience at the Rävlanda Sanatorium is reflected in the scholarly account of the condition. It includes information on the results of treatment in the prechemotherapeutic era as well as in the present time. Conservatism in surgery is advocated, but he still believes, as do many others, that if the kidney must be removed the ureter should also be taken.

Campbell Begg writes with authority on Parasitic Infections of the Genito-urinary Tract. Ambrose King gives a full account of the modern views on Syphilis and other venereal diseases (excluding gonorrhœa).

Vol. 6, *Endoscopy*: Except for a short section on the organization in the Munich Urological Hospital written in German by May, this volume is entirely American. It comes from Barnes, Bergmann, and Hadley in Los Angeles and is concerned with endoscopes and their use, with very full accounts of the normal and abnormal appearances seen through them. This is followed by a description of Endoscopic Surgery. It is apparent that the authors are ardent resectionists; they give a detailed description of the operation of endoscopic prostatic resection as well as its complications and their treatment. There are many clear illustrations, including a large number in full colour.

These books should certainly be in every large medical library. We look forward to the appearance of the remaining volumes and hope that they will not be long delayed. They will be the standard work for many years and the quality of their make-up leaves nothing to be desired. The publishers and editors are to be congratulated on the successful launching of this comprehensive treatise.

Surgical Treatment of Bone and Joint Tuberculosis. By ROBERT ROAF, M.A., M.Ch.Orth., F.R.C.S. (Ed.), F.R.C.S.(Eng.), Robert Jones and Agnes Hunt Orthopædic Hospital, Oswestry; W. H. KIRKALDY-WILLIS, M.A., M.D., B.Chir., F.R.C.S.(Ed.), Orthopædic Centre, Nairobi, Kenya; and A. J. M. CATHRO, M.B., Ch.B., Orthopædic Centre, Nairobi, Kenya. 9¼ × 6½ in. Pp. 137 + viii, with 90 illustrations. 1959. Edinburgh and London: E. & S. Livingstone Ltd. 30s. net.

IN England to-day tuberculosis of the bones and joints is becoming a rare condition and surgeons find it difficult to obtain cases for demonstration purposes in order to teach the students. Nevertheless, there are still some cases which gravitate to centres such as Oswestry, where quite a good number may be seen.

However, in India, the Far East, and in Africa tuberculosis is still very common in all its forms.

Robert Roaf and his co-authors have written a most useful and very interesting monograph on skeletal tuberculosis. This book is very practical, is beautifully illustrated, and well presented. It should prove a valuable guide for surgeons who are often called upon to treat bone and joint tuberculosis, and it will act as an excellent reference volume for those who treat this condition occasionally. It will be the reference book for those who are working for higher surgical degrees or diplomas.

A Short Textbook of Surgery. By C. F. W. ILLINGWORTH, C.B.E., M.D., Ch.M., F.R.C.S. (Ed.), F.R.F.P.S. (Glas.), Hon. F.A.C.S., Hon. F.R.C.S. (Eng.), Regius Professor of Surgery, University of Glasgow. Seventh edition. 9¼ × 5¾ in. Pp. 547 + viii, with 263 illustrations. 1959. London: J. & A. Churchill Ltd. 45s.

WE would like to congratulate Professor Illingworth on the twenty-first birthday of his book. It is fitting that this new seventh edition should appear just twenty-one years after the first edition. What a tremendous change has come over the face of surgery in those all too short twenty-one years.

This new edition has been thoroughly revised and many chapters have been rewritten or radically altered. It is a first-class text-book for the modern medical student and it will prove as popular as the former editions.

Treatment of Cancer in Clinical Practice. Edited by PETER B. KUNKLER, M.A., M.D. (Cantab.), M.R.C.P., F.F.R., Radiotherapist, United Birmingham Hospitals; and ANTHONY J. H. RAINS, M.S. (Lond.), F.R.C.S., Professor of Surgery, University of London. 9¼ × 6½ in. Pp. 821 + xvi. 1959. Edinburgh and London: E. & S. Livingstone Ltd. £5 net.

THIS is an enlightened and stimulating work, dealing with the treatment of cancer. The whole body is covered and each of the forty chapters in the book has been entrusted to an expert in his own particular line. It is difficult to single out any particular section as the whole book is so well presented, and it is authoritative.

There has been a demand for such a work as this for a long time, and the younger generation of surgeons will hail its arrival.

It is pleasing to see the excellent co-operation between an experienced radiologist and a practical surgeon in the building up of this work. They have chosen their numerous collaborators well and the whole work is closely interwoven, so that there is no repetition in the various and numerous chapters. Professor Rains has written an admirable chapter on the approach to surgical methods and technique; this should prove of real value to the senior resident and registrar, for the information contained in this chapter is difficult to obtain elsewhere.

Professor Milnes Walker deals with the difficult problem of malignant disease of the pancreas, duodenum, and biliary tract in a masterly fashion and gives some interesting statistics.

There can be little doubt that this book will become the standard guide to all those who are endeavouring to become specialists and require a higher qualification in surgery or any of its branches, including gynæcology.

As a reference volume this book could not be bettered, and we would like to congratulate the editors and their team on an excellent production.

Treatment of Cancer and Allied Diseases. Volume III. **Tumours of the Head and Neck.** Edited by GEORGE T. PACK, M.D., F.A.C.S., Attending Surgeon, Memorial Center for Cancer and Allied Diseases, New York; and IRVING M. ARIEL, M.D., F.A.C.S., Associate Clinical Professor of Surgery, New York Medical College. Second edition. 10 × 6½ in. Pp. 781 + xviii, with 1028 illustrations. 1959. London: Pitman Medical Publishing Co. Ltd. £11 11s. net.

THE third volume of this nine-volume work is devoted to the treatment of malignant tumours of the head and neck, and the seventy authors who contribute to this

volume have been drawn from the United States, Great Britain, South Africa, Canada, Denmark, and France. Naturally with this array of surgical talent one would expect something out of the ordinary, and this is the case, for this third volume contains a wealth of important material and the whole volume is beautifully illustrated with coloured drawings, clinical photographs, black and white drawings, radiographs and photomicrographs.

The place of surgery in the treatment of malignant disease is carefully chosen, and the indications for treatment by radiotherapy are set out in an interesting and practical manner. The value of a combined approach is considered in detail.

The specialist, whether practising in the field of general surgery, head and neck surgery, neurosurgery, oral surgery, plastic surgery, radiotherapy, ear, nose, and throat surgery, or pathology, will find much to interest him and contribute to his knowledge by reading this book.

We look forward to seeing the remaining volumes of this comprehensive and important work.

Speech and Brain Mechanisms. By WILDER PENFIELD and LAMAR ROBERTS. 9 × 6 in. Pp. 286 + xiv, fully illustrated. 1959. Princeton, New Jersey: Princeton University Press. (London: Oxford University Press.) 35s.

THIS very interesting and scientific monograph incorporates the Vanuxem Lectures delivered by Professor Wilder Penfield at Princeton University in February, 1956.

The book gives an up-to-date interpretation of the speech area in the human brain and as such will be the reference work on this subject for many years to come.

The whole speech area of the human brain has now been mapped out and many patients have undergone cortical excision for certain lesions. The late effects of these excisions have been carefully assessed.

The illustrations in this monograph are excellent. There is a comprehensive bibliography and a case index in addition to a general index.

This volume is the result of a decade of continuous research, and will prove of real value to physiologists, neurologists, and neurosurgeons.

Disorders of the Temporomandibular Joint. By LASZLO SCHWARTZ, D.D.S., Clinical Professor of Dentistry, Columbia University. 10 × 6¾ in. Pp. 471 + xxiv, with 168 illustrations. 1959. Philadelphia and London: W. B. Saunders Co. 105s.

PROFESSOR SCHWARTZ and his eighteen contributors have written a most comprehensive work on the temporomandibular joint and this includes the diagnosis, management, and relation to occlusion of teeth. This book is profusely illustrated and the radiographs are of high quality.

It is true that operative intervention is rarely, if ever, required to-day for a displaced meniscus or clicking jaw, for by regular remedial exercises of this joint and by dental alinement these conditions can be cured.

It seems a great pity that a book of this calibre should almost ignore the great part British surgeons and dental surgeons have played in the surgery of this joint.

Recent Advances in Surgery. Edited by SELWYN TAYLOR, D.M., M.Ch., F.R.C.S., Surgeon, King's College Hospital, London. Fifth edition. 8 × 5¼ in. Pp. 500 + xiv, with 160 illustrations. 1959. London: J. & A. Churchill Ltd. 60s.

IT is just over five years since the fourth edition of this book appeared and much has changed even in that short space of time. The new editor, Selwyn Taylor, has gathered around him a team of men all of whom are acknowledged to be experts in their own particular field of surgery or surgical research. The outcome of this enterprise is that the reader is presented with a volume containing twenty-nine excellent chapters dealing with real advances in surgery—to mention a few: open heart surgery; cross-infection; the ischæmic leg; arterial reconstruction; body fluids; hydrocephalus; liver resection; and the endocrines.

This book is well illustrated, there being some 160 illustrations to the 500 pages of text. One of the most useful features of this book is the very comprehensive and up-to-date list of references which are to be found at the end of each chapter. There can be little doubt that this fifth edition will prove of real worth not only to the postgraduate who is working for a higher degree or diploma, but to the younger generations of surgeons who wish to be kept up to date in all branches of surgery.

We agree with Sir James Paterson Ross, P.R.C.S., who writes the foreword, that "The Editor is to be congratulated upon his choice of subjects, for he has included all the important fields of current surgical endeavour".

An excellent and most useful production.

Nouvelle Pratique Chirurgicale Illustrée. Fascicule xiv. By JEAN QUÉNU. 10½ × 6⅝ in. Pp. 266, with 222 illustrations. 1959. Paris: Gaston Doin et Cie. 3500 fr.

THIS, volume xiv of a series edited by Professor Jean Quénu, deals with the following operations: Repair of sub-umbilical incisional hernia (Jean Quénu); Treatment of hydatid of the liver by partial cystectomy (Claude Dubost); Treatment of imperforate anus with vulvar fistula (Assad Rizk); Epididymectomy for tuberculosis (Louis Quénu); Suture of ruptured quadriceps using plantaris tendon (François Dubois); Plastic reconstruction of ligaments in severe sprain of the knee (I. P. Dejouany); Meniscectomy for rupture of medial meniscus (Jean Validire).

Each operation is described by a few pages of letterpress and about thirty full-page drawings from an actual case by P. Rivallain.

The operative steps could be illustrated in sufficient detail by fewer drawings, with a consequent lowering of the price. It is difficult to imagine a reason for the lack of systematic arrangement which must surely detract from the usefulness of the series. The drawings are excellent.

Orthopaedics, Principles and their Application. By SAMUEL L. TUREK, M.D. Attending Orthopaedic Surgeon, Weiss Memorial Hospital. 10 × 7 in. Pp. 906 + xx, with 600 illustrations. 1959. London: Pitman Medical Publishing Co. Ltd. £8.

THIS is a large comprehensive work on orthopædic surgery. It covers the basic sciences of Anatomy, Embryology, Physiology, and Pathology as they are related to orthopædics. To-day orthopædics is a large branch of surgery and covers such a large part of the body. This book in some ways takes the place of that well-known work on orthopædics by Jones and Lovett, the second edition of which appeared as far back as 1929.

During the last decade there have been many new developments in orthopædic surgery and the impact of vaccines, antibiotics, and radio-active isotopes have considerably changed orthopædic practice. All these new forms of treatment are incorporated in this work. The book is lavishly illustrated with some 600 drawings and radiographs and 53 coloured plates.

An excellent production and a useful reference volume.

Le Nouveau-Né. By MARCEL FÈVRE. 9¾ × 6 in. Pp. 200, with 28 illustrations. 1959. Paris: G. Doin et Cie. 2500 fr.

THIS volume of some 200 octavo pages of rather large print is one of a "Therapeutic Library" of which some forty other volumes are either available or in preparation. A glance at some of the other titles suggests that if the volumes are of equal size the subjects are probably treated in much greater detail than is the case here.

In British pædiatric surgical practice the phrase 'neonatal surgery' has a precise meaning which is not followed in this work, in which such subjects as hare-lip, hypospadias, ectopia of the bladder, and congenital dislocation of the hip, amongst many others, are discussed. It is, indeed, a description of the surgical conditions of the neonatal period and of early childhood, with a discussion of the indications for treatment and prognosis rather than a work on the minutiæ of neonatal surgical practice.

An introductory note explains that the volume is intended primarily to inform the general practitioner about the lesions he may find at birth and in early infancy, so that he may discuss their management and prognosis intelligently with the anxious parents. This purpose is admirably fulfilled.

Lectures on the Interpretation of Pain in Orthopedic Practice. By ARTHUR STEINDLER, M.D. 10 × 6¼ in. Pp. 734 + xviii, fully illustrated. 1959. Springfield, Illinois: Charles C. Thomas. (Oxford: Blackwell Scientific Publications Ltd.) £7 8s.

THIS large monograph contains some sixteen lectures dealing with pain and its association with various orthopædic conditions. The matured clinical acumen and experience of Arthur Steindler make these lectures of real value not only to orthopædic surgeons but to neurologists and general surgeons as well. Pain in joints, muscles, tendons, and fasciæ, and ostalgia, causalgia, and phantom pain are all considered in detail and the appropriate treatment is advised.

Cervical pain syndrome, lumbosacral pain, and sciatica, as well as other pain syndromes, are covered in a very practical way.

The book is illustrated by some excellent anatomical dissections by Dr. Rudolfo Cosentino, of La Plata, Argentina.

There can be little doubt that this book will prove of real value to all who are interested in the problem of pain.

A Catalogue of the Portraits and other Paintings, Drawings and Sculpture in the Royal College of Surgeons of England. By WILLIAM LEFANU, Librarian of the College. 9¾ × 7 in. Pp. 119 + xii. Fully illustrated. 1959. Edinburgh and London: E. & S. Livingstone Ltd. 30s.

THE College of Surgeons is indeed fortunate to have such an excellent catalogue of the portraits and paintings at the College. The publication of this up-to-date and most informative catalogue has been made possible by a gift from Mr. McNeill Love in memory of his son, Michael.

This is the third catalogue of the portraits and busts at the College; the first two were the work of Sir Frederic Hallett and are now out of print. In this new catalogue Mr. LeFanu has included 245 painted or carved portraits, together with a further 113 works which are not portraits of surgeons. There are 4 coloured plates—namely, John Hunter, William Cheselden, Caesar Hawkins, and a Rhinoceros by George Stubbs. The book is divided into two parts, the first dealing with portraits and the second with paintings, drawings, and sculpture. There are 297 illustrations in this catalogue, and all the important pictures in the Royal College of Surgeons have been reproduced.

As one would expect, Mr. LeFanu has performed his task with infinite and meticulous care; besides the pictures there is a list of portraits in alphabetical order, an index of artists, an index of subjects, and a general index – in fact, this is a perfect catalogue.

Every Fellow of the College of Surgeons will no doubt want to possess this excellent catalogue, for it gives an admirable account of some of the great possessions of the College.

The book is of a convenient size and the portraits are beautifully exhibited on good paper. The crest of the College is reproduced in gold on the cover. An excellent creation, and the price is very moderate.

Lectures on the Scientific Basis of Medicine. Volume VII, 1957-58. 8½ × 5½ in. Pp. 496 + xii, illustrated. 1959. London: University of London, The Athlone Press. 45s.

THE medical profession have come to enjoy the yearly appearance of these lectures in book form. Sir Francis Fraser has performed a great service to the profession for his forethought in instigating these lectures some nine years ago. He has succeeded in providing excellent lectures each year. The present volume contains twenty-three lectures from the series in 1957-58. All the contributors are actively engaged in research and they present their lectures in a most interesting manner.

Surgeons will be interested in Yoffey's article on "Some Problems of Lymphoid Tissue".

The Mediastinum. By TED F. LEIGH, M.D., and H. STEPHEN WEEKS, M.D. 9¾ × 6¼ in. Pp. 246 + x, with 290 illustrations. 1959. Springfield, Illinois: Charles C. Thomas. (Oxford: Blackwell Scientific Publications Ltd.) 92s.

THIS is an interesting and practical monograph dealing with all types of common and rare lesions of the mediastinum. The great value of the book lies in its comprehensiveness, covering as it does lesions and tumours of the lungs, intramediastinal structures, and lesions extending into the mediastinum from paramediastinal structures such as meningoceles, and lesions of the thyroid and parathyroids.

The numerous radiographs which illustrate this monograph are of a high order and are well reproduced.

There can be little doubt that this book will take its place as the important reference volume on the radiological conditions of the mediastinum. It should make a strong appeal to all clinicians, as it presents something new in the radiology of the chest.

Gowland and Cairney's Notes of Anatomy. Volume 3. Part I. The Limbs. Part II. The Vertebral Column, Ribs and Sternum. Edited by W. E. ADAMS, Ph.D. (Leeds), D.Sc., M.Sc., M.B., Ch.B., B.Med.Sc. (N.Z.), F.A.Z., F.R.S.N.Z., Professor of Anatomy, University of Otago. Second edition. 8½ × 5½ in. Pp. 475 + xv. 1959. Christchurch, N.Z.: N. M. Peryer Ltd. 57s. 6d.

THESE useful anatomical notes were first published in 1951 under the editorship of Dr. Gowland and Dr. Cairney. This new second edition has been entirely revised and is in fact a new publication, with no less than five editors. There are no illustrations, but the text is very readable and clear. This third volume is devoted to the anatomy of the limbs, the vertebral column, ribs, and sternum.

It is refreshing in a book on anatomy to see information on applied anatomy, and throughout these notes the

aspect of clinical or applied anatomy is stressed. The anatomy student will always respond to some clinical anatomy during his early days, as this applied aspect of anatomy stimulates him to see the real necessity of learning anatomy. These anatomy notes, although born in the University of Otago, will prove of real value to students in other universities. It is depressing to read that many medical students to-day have no knowledge of Latin and therefore an appendix is included which is called "Latin in Anatomy". With the extended school facilities up to the age of 16 years, it is hoped that Latin may be a subject to be studied by science students of the future.

Napoleon Immortal. The Medical History and Private Life of Napoleon Bonaparte. By JAMES KEMBLE, Ch.M., F.R.C.S. 8¼ × 5¼ in. Pp. 307 + xii, illustrated. 1959. London: John Murray. 28s.

THIS is an interesting and an attractive account of the medical history and private life of Napoleon Bonaparte told by a practical surgeon who has a flair for historical narrative. Although many books have been written about Napoleon, this book contains quite a wealth of new knowledge; Mr. Kemble has given us the medical history of this great man from the cradle to the grave.

The book is written in a lucid and intriguing style and once the reader commences to read he is not satisfied until he has finished the whole text, and, what is more, it is one of those rare books which invite one to read it a second time.

Histonomy of the Cerebral Cortex. By S. T. BOK, Head of the Netherlands Central Institute of Brain Research. 8¾ × 5½ in. Pp. 434 + x, with 175 illustrations. 1959. Amsterdam: Elsevier Publishing Company. (London: D. Van Nostrand Co. Ltd.) 72s.

THIS book contains a quite new approach to the finer structures of the cerebral cortex in man and animals. Professor Bok has been studying the histonomic method for over twenty-five years and the material he has accumulated is extensive.

Although part of the book deals with the intricate measurement of nerve-cells and their dendrites, which appears a complicated process, yet the book for the most part makes interesting reading.

Histologists, neurologists, and anatomists will find this book particularly interesting.

Modern Trends in Accident Surgery and Medicine. Edited by RUSCOE CLARKE, M.B.E., F.R.C.S., and F. G. BADGER, B.Sc., F.R.C.S. (Ed.), and SIMON SEVITT, M.D., M.Sc., F.R.C.P.I., D.P.H., The Birmingham Accident Hospital. 9½ × 6½ in. Pp. 330 + xii, and 16 page index. 82 illustrations. 1959. London: Butterworth & Co. (Publishers) Ltd. 75s.

THE publication of this book is timely when there is an ever-increasing accident rate on the roads to-day both at home and abroad.

This book is the product and the teaching of the Birmingham Accident Hospital. It is sad to note that the sudden and untimely death of Ruscoe Clarke occurred soon after this book was completed and while it was in the press.

It is pleasing to note that the title of this book is comprehensive, including both surgical and medical accidents; this is as it should be, as a modern understanding of accident cases involves the patient as a whole. Every aspect of the accident case is covered in a very practical way. Burns and Anæsthesia are not covered, as they have appeared in separate monographs.

The illustrations throughout this book are excellent and have been well chosen. The operative treatment of fractures is portrayed in a very interesting and practical fashion.

This is one of the really important books of the year. It will be the guide to all surgeons who have to deal with trauma, and it will prove of real value to the surgical postgraduate who is working for a higher degree.

Christopher's Minor Surgery. Edited by ALTON OCHSNER, M.D., F.A.C.S., Professor of Clinical Surgery, Tulane University School of Medicine; and MICHAEL E. DEBAKEY, M.D., F.A.C.S., Professor of Surgery, Baylor University College of Medicine. Eighth edition. 10 × 6½ in. Pp. 539 + xvi, with 347 illustrations. 1959. Philadelphia and London: W. B. Saunders. £3 13s. 6d.

IT is just thirty years ago that the first edition of the *Minor Surgery* was published and from that day to this, through succeeding editions, this work has proved to be very popular on both sides of the Atlantic.

This new eighth edition, with its 24 contributors, covers in a most comprehensive way all the aspects of minor surgery. Perhaps there is a tendency for the surgeon in America to undertake more surgery in his office or consulting room than is usual in this country. Arteriograms would be performed in the hospital or nursing home, notwithstanding the surgeon having an X-ray unit in his consultation suite.

The minor surgery of the eye, ear, nose, and throat are well protrayed in this volume. There can be little doubt that the present edition will prove as popular as its predecessors.

Chirurgisches Nahtmaterial. By HAROLD HUDEMANN, Prof. Dr. Med. Director of the Hygiene Institute, of Medizinischen Akademie, Magdeburg. 9½ × 6½ in. Pp. 144, with 35 illustrations. 1959. Jena: Veb Gustav Fischer. D.M.13.50.

IF the surgeon takes anything for granted in his practice, it is probably his suture material. Provided he can indulge his preferences – some theatre sisters might term them his 'fads and fancies'— and so long as his wounds heal soundly and cosmetically, it matters little how catgut is sterilized or standardized.

However, for those interested who can also read German, here is a little book which illuminates this 'back-room' subject. It seems, and there is nothing new in this, that no one suture material is perfect. What may seem surprising is that pleated or woven plastic, non-absorbable materials, are said to be less durable and stretch more readily than equivalent mono-filament preparations. On the question of carcinogenesis, which certain of these materials have displayed in animals, we are reassured.

Regarding sterilization of catgut, the book prefers chemical to thermal techniques, but mention is made of a method utilizing electronic bombardment. Speculation on the possibility that reaction to catgut, if not infective in nature, could be allergic, appears to be groundless.

The book is certainly a fount of information, but it lacks clarity of presentation as the subject-matter is in part highly technical; the reader misses discussions and summaries setting forth clear and definite conclusions.

Anesthesia for Infants and Children. By ROBERT M. SMITH, M.D., Anesthesiologist, The Children's Medical Center, Boston, Mass., U.S.A. 9½ × 6½ in. Pp. 418, with 182 illustrations. 1959. St. Louis: C. V. Mosby Co. (London: Henry Kimpton.) 90s.

THE name of Dr. Smith is well known in pædiatric anæsthesia and this book will enhance his reputation, for it is clearly the work of one who is a master of his subject.

The book is essentially practical in its approach, and the descriptions of procedures and techniques include the details which make all the difference.

Few aspects of pædiatric anæsthesia are not dealt with. There are chapters on anæsthesia for special types of surgery in children, on hypothermia and hypotensive techniques, on local analgesia and on the use of relaxants, and on fluid and electrolyte balance and blood replacement. This latter chapter is a most helpful one and takes full account of the important differences between the physiopathology of children and that of adults.

Dr. Smith prefers simple methods to complex ones. His book contains a great deal of common sense, and the perplexed houseman will not consult this in vain. His seniors, too, can read it with satisfaction. It is well produced, and the illustrations—many of which show unusual surgical conditions—are illuminating.

Peripheral Facial Palsy. Pathology and Surgery. By KARSTEN KETTLE, M.D. 9¾ × 6¼ in. Pp. 341, with 127 illustrations. 1959. Oxford: Blackwell Scientific Publications Ltd. £6.

THIS is a monograph dealing with a highly specialized subject—namely, peripheral palsy of the facial nerve. It is an important subject when it is considered that the facial nerve is more often paralysed than any other nerve; also this subject receives little attention in surgical text-books.

Although it is less than forty years ago that the first intratemporal nerve suture was performed, yet during that time great strides have been made by Ballance and Cawthorne in this country and by Kettel in Denmark. It is fitting therefore that Dr. Kettel should present his unique experience to the medical profession at large, and that Mr. Terence Cawthorne should write a foreword to the book.

The book may be said to include two large sections: non-traumatic and traumatic facial palsies.

In this traumatic age with its numerous cranial injuries the facial nerve frequently suffers damage.

The author gives a detailed account of his operations on the facial nerve and the pre- and post-operative clinical photographs speak for themselves and make the book very attractive to the clinician.

The book also includes a number of coloured slides of pathological and anatomical observations taken under the microscope during operations.

A very complete bibliography is included in this excellent monograph.

Metabolic Care of the Surgical Patient. By FRANCIS D. MOORE, M.D., Moseley Professor of Surgery, Harvard Medical School. 10¾ × 7¾ in. Pp. 1011 + x, with 142 illustrations. 1959. Philadelphia and London: W. B. Saunders Co. 140s.

THIS large and comprehensive work is based wholly on experience in the study and care of the sick in Professor Moore's wards at Peter Bent Brigham Hospital during the last fifteen years. No one is better fitted to write such an extensive work as this, for he has made this subject his own particular research problem.

This work is divided into six parts. Part 1 deals with the normal patient, normal convalescence, and the metabolism of recovery. Part 2 is concerned with blood-volume, hæmorrhage, plasma loss, transfusion, and hypervolæmia. Part 3 is devoted to body fluid and electrolyte: water, salt, and acid. This section is very interesting and rightly so as Professor Moore has added so much to our knowledge on this subject. Part 4 is allotted to loss of body substance and the clinical management in surgical starvation. Part 5 deals with visceral disease in surgical patients. Part 6 is concerned with fractures, wounds, and burns—a very practical section which will prove of interest to most surgeons in this modern world.

There is an excellent and detailed appendix in which surgical diets are discussed. A very complete bibliography is found at the end of this work.

There can be little doubt that this is the book of the year. An outstanding production which every surgeon must have in his library for ready reference.

BOOK NOTICES

[*The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest to our readers.*]

Xylocaine. The Pharmacological Basis of its Clinical Use. By STEN WIEDLING. The Research Laboratories of A. B. Asha, Sodertalje, Sweden. 7$\frac{9}{16}$ × 5 in. Pp. 146, with 24 figures. 1959. Stockholm: Almquist & Wiksell. Sw. Kr. 20.

I Diverticoli dell'Esofago. By GIULIO R. BETTOLO and GUIDO FRANZINI. 9⅞ × 6$\frac{7}{16}$ in. Pp. 203, with 60 illustrations. 1959. Milan: Unione Tipografica.

The Nuffield Foundation Fourteenth Report. Report of the year ended March 31, 1959. 8½ × 5½ in. Pp. 201 + xii. 1959. Oxford: The University Press.

Fundamental Techniques of Plastic Surgery and their Surgical Applications. By IAN M. MCGREGOR, M.B., F.R.C.S.(Eng.), F.R.F.P.S.(Glas.), Consultant Plastic Surgeon, Glasgow Royal Infirmary. 8⅝ × 5½ in. Pp. 244 + viii, fully illustrated. 1960. Edinburgh & London: E. & S. Livingstone Ltd. 30s.

Biological Problems of Grafting. A symposium. Edited by F. ALBERT and P. B. MEDAWAR. 9½ × 6 in. Pp. 453 + xii, illustrated. 1959. Oxford: Blackwell Scientific Publications. 50s. Published for the University of Liège and the Council for International Organizations of Medical Sciences.

Bibliography of Cancer produced by Pure Chemical Compounds. A survey of the literature up to and including 1947. By OTTO NEUBAUER, M.D. 9 × 6 in. Pp. 604 + xxviii. 1959. London: Oxford University Press. 42s.

Cancer. Volume 6. Edited by RONALD W. RAVEN, O.B.E.(Mil.), T.D., F.R.C.S., Joint Lecturer in Surgery, Westminster Medical School, University of London. 9½ × 6¼ in. Pp. 500 + x, with 138 illustrations. 1959. London: Butterworth & Co. Ltd. 85s.

Osteochondritis Dissecans. Loose Bodies in Joints, Etiology, Pathology, Treatment. By I. S. SMILLIE, O.B.E., Ch.M., F.R.C.S.(Ed.), F.R.F.P.S., Lecturer-in-Charge, Department of Orthopædic Surgery, University of St. Andrews. 9½ × 6½ in. Pp. 224 + viii, fully illustrated. 1960. Edinburgh and London: E. & S. Livingstone Ltd. 60s.

Surgery of Repair as Applied to Hand Injuries. By B. K. RANK, C.M.G., M.S.(Melb.), F.R.C.S. (Eng.), F.R.A.C.S., Hon. Plastic Surgeon, Royal Melbourne Hospital; and A. R. WAKEFIELD, M.S.(Melb.), F.R.C.S.(Eng.), F.R.A.C.S., Plastic Surgeon, Royal Children's Hospital, Melbourne. Second edition. 9¼ × 6½ in. Pp. 284 + xiv, with 219 illustrations. 1960. Edinburgh and London: E. & S. Livingstone Ltd. 45s.

Forschungsberichte des Landes Nordrhein-Westfalen. No. 679. Die Verletzungen der Autoinsassen. Edited by GERNOT BÜTTNER. 11½ × 8 in. Pp. 394, with 180 illustrations. 1959. Cologne: Vestdeutscher Verlag. D.M.66.

Thérapeutique Chirurgicale des Ictères des Rétention. By P. GOINARD and G. PÉLISSIER. 9¼ × 6¼ in. Pp. 210, with 82 illustrations. 1959. Paris: Masson. 3200 fr.

Autogenous Vein Grafts and Related Aspects of Arterial Disease. By W. ANDREW DALE, M.D., Assistant Professor of Clinical Surgery, Vanderbilt University School of Medicine, Nashville, Tennessee. 9 × 5¾ in. Pp. 123 + xiv, with 31 illustrations. 1959. Springfield, Illinois: Charles C. Thomas. (Oxford: Blackwell Scientific Publications Ltd.) 48s.

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British Surgical Practice, Surgical Progress 1959. Edited by Sir ERNEST ROCK CARLING, LL.D., F.R.C.S., F.R.C.P., F.F.R., Honorary Consulting Surgeon, The Westminster Hospital; and Sir JAMES PATERSON ROSS, K.C.V.O., LL.D., M.S., F.R.C.S.(Eng.), F.R.C.S.(Ed.), F.R.A.C.S., F.A.C.S., F.F.R., Surgeon, St. Bartholomew's Hospital, London. 9¼ × 6¼ in. Pp. 391 + x, with 90 pp. Index and 93 illustrations. 1959. London: Butterworth. 52s. 6d.

Actualités de Chirurgie Orthopédique et Reparatrice. A series of lectures and discussions given at the Cochin Hospital, Paris. Edited by MERLE D'AUBIGNE. 10¾ × 8¼ in. Pp. 86, fully illustrated. 1959. Paris: L'Expansion Scientifique Française.

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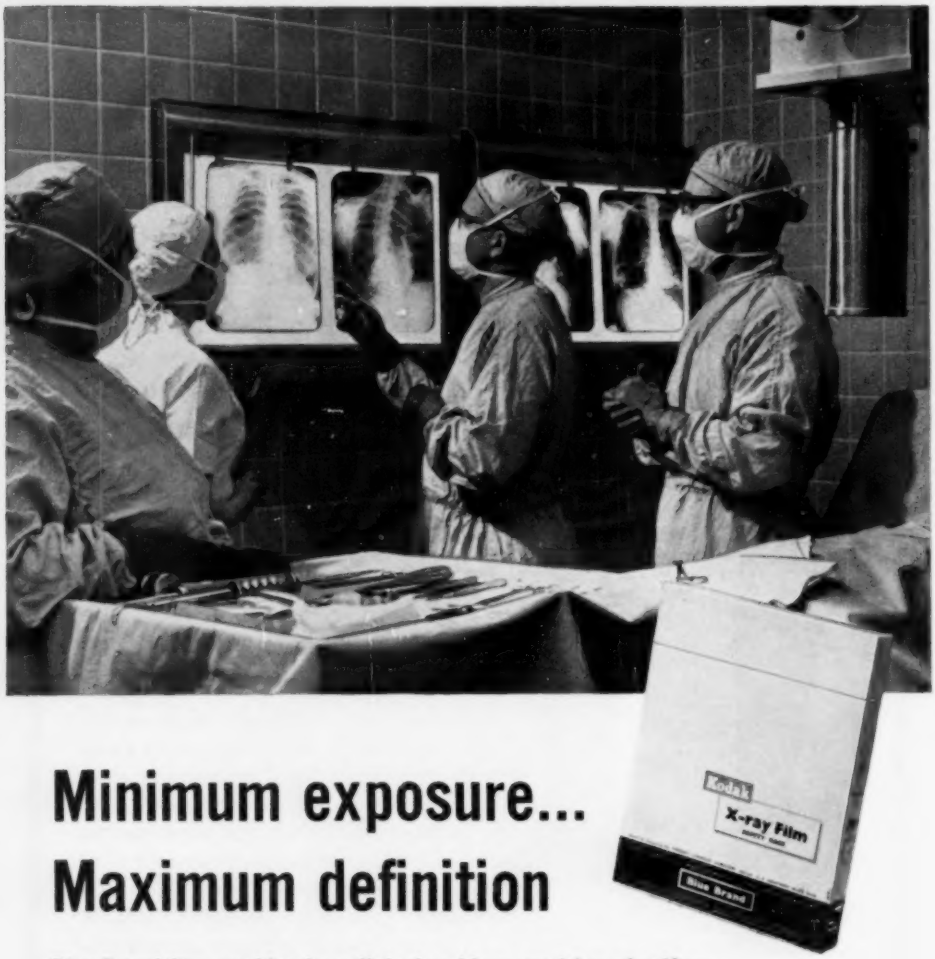

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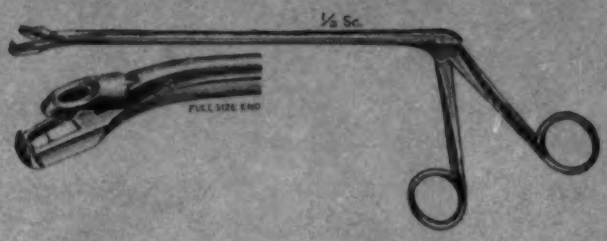

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